

num, the semilunar, and the cuneiform bones of the carpus have been found injured in cases supposed clinically to be only severe sprains. When fracture of one or more carpal bones accompanies a fracture of any of the related long bones of the hand or wrist, it may be overlooked even in the X-ray examination, unless the entire part is subjected to scrutiny.

But in the case of a simple sprain an adequate X-ray examination comparing both hands under the axis of the rays will show normal bone. If inflammation is present the diagnosis of the nature of the arthritis may be assisted by X-rays. If an ununited fracture or necrosis existed it would show on the negative with a normal condition of the remaining bones and cartilages. A previous history leading to the diagnosis of rheumatoid arthritis would be reinforced if the negative showed ulceration or destruction of the cartilages. The radiograph will be distinguished between an old fracture in the body of a bone and a necrotic process following the destruction of the cartilage surrounding the bone. The more or less clean breaks of the bone with inflammatory exudate surrounding it would indicate a fracture, while a negative showing a more or less irregular breaking down of several carpal bones would point to an advanced case of rheumatoid arthritis. If the radiograph shows a more or less diffusion of inflammatory exudate throughout the carpus when an arthritis is discovered after the prolonged immobilization of the wrist-joint for injury about the lower end of the forearm, it would indicate a not infrequent type of arthritis, which may develop in cases tied up too long with the idea of getting a better union of the fragments. If the examination is not made till long afterward, however, the necrotic appearance on the negative will resemble somewhat a radiograph of an advanced case of rheumatoid arthritis, but the history and the condition of other bones will interpret the diagnosis. It may not be out of place here to say that, both in recent and older cases of any of these conditions, the best therapeutic results may be obtained by certain applications of electricity and motor-massage, full directions for which are given by the author elsewhere.

## CHAPTER XXX

### X-RAYS IN MILITARY SURGERY

#### STUDIES AND CONCLUSIONS OF EXPERIENCE.

CERTAIN lessons derived from X-ray experience in military surgery contain instruction for the general surgeon who deals with similar injuries in times of peace. The major *lessons* that appear from the Surgeon General's report of X-ray work in our war with Spain will here be grouped for the reader in concise form. Official documents are closely followed.

"During 1898 the United States Army had twelve X-ray coils and five Static machines. When working properly both apparatus produce X-rays of practically equal power and efficiency, but are so utterly unlike in construction and require such different means for their manipulation that they are not under all conditions equally adapted to the requirements of military surgery.

"The use of the X-ray has marked a distinct advance in military surgery. It has favored conservatism and promoted the aseptic healing of bullet-wounds made by lodged missiles in that it has done away with the necessity of exploration by probes and obviated the dangers of infection and additional traumatism in this class of injuries. In gunshot fractures it has been of great scientific value in showing the character of the bone lesions, the form of fracture, and the amount of bone comminution produced by the small-calibre and other bullets—*information which could not otherwise be obtained in the living body.*

"In the treatment of these traumatisms the X-ray has been of great value in determining the course to be pursued, as its use, together with the course of cases under treatment, has shown that the *aseptic* or *septic* condition of the wound is of far greater importance than the amount of bone comminution. This is illustrated by cases of extensive comminution with aseptic wounds which progressed favorably with a minimum of immediate and remote ill-effects; while cases of slight bone traumatism with infected wounds were much more difficult to treat and more serious in results.

"Of the total number of wounded coming under treatment on the American side during the Spanish War the mortality was only 6.64 per cent. In ten other tabulated wars it ranged from ten to fifteen per cent. An effort was made to determine how much of this



reduction was due to the use of small-calibre bullets of high velocity and how much to improved surgery. The small-calibre bullet led to conservative treatment in a greater proportion of cases than in the Civil War, and in cases so treated the mortality was reduced from 9.1 to 0.4 per cent. But from the fact that only extremely grave cases were treated by amputation or excision the mortality in operated wounds of the extremities is only reduced from 21.6 per cent. for the Rebellion to 18.7 per cent. for the war with Spain.

"It is concluded that in the classes of wounds showing a marked reduction in mortality in the later war this reduction was related to the increase of *conservative treatment*, yet the increased conservatism was not wholly due to the use of the smaller bullet, for X-ray examinations show that in compound fractures the amount of bone comminution is generally as great with the new missile as with the old. Observations with shrapnel wounds also indicate that slow-moving lead bullets very frequently produce wounds as aseptic as the new bullets of high velocity. The increased conservatism to which seems due the improved results rather than to 'merciful fire-arms,' is, therefore, credited to the recognition of the general aseptic nature of bullet wounds, the use of occlusive dressings to preserve their aseptic state, and the efficiency of antiseptic methods of treating septic wounds. *In enabling the surgeon to preserve the asepticity of bullet-wounds by doing away in many cases with the necessity of immediate exploration the X-ray has played an important part.*

**Lodged Missiles.**—"Lodged bullets only in extremely rare cases require immediate removal. Surgical interference with such bullets, except where adequate asepsis is available or the necessity urgent, is to be condemned, as suppuration is much more detrimental to the patient than the presence of the missile. In perforating wounds made by the modern bullet the positions of entrance and exit and the symptoms, together with tests made on dead bodies, show that the bullet almost invariably takes a direct course through the part hit irrespective of the tissues, be they soft parts or bone, which may lie in its course.

"In many cases a small-calibre compound bullet which has ricocheted may, from its irregularity of flight, produce an extremely jagged wound. Striking the body while oscillating or turning on its long axis it may cause an external wound of large size and laceration.

"The shrapnel bullet used by the Spaniards was a round, soft-lead ball belonging to the large calibre, low velocity type, and, theoretically, should have produced wounds differing materially from the Mauser. Practically there was not so much difference as was expected, and the wounds which had been given a primary dressing with the first-aid packet generally healed as readily as those made by the Mauser. Reported cases show that in many instances the nature of the missile could not be determined, either by the appearance of the entrance-wound or the sensation of the man, and many shrapnel wounds were thought to be Mauser wounds till the X-ray or removal proved them to be shrapnel.

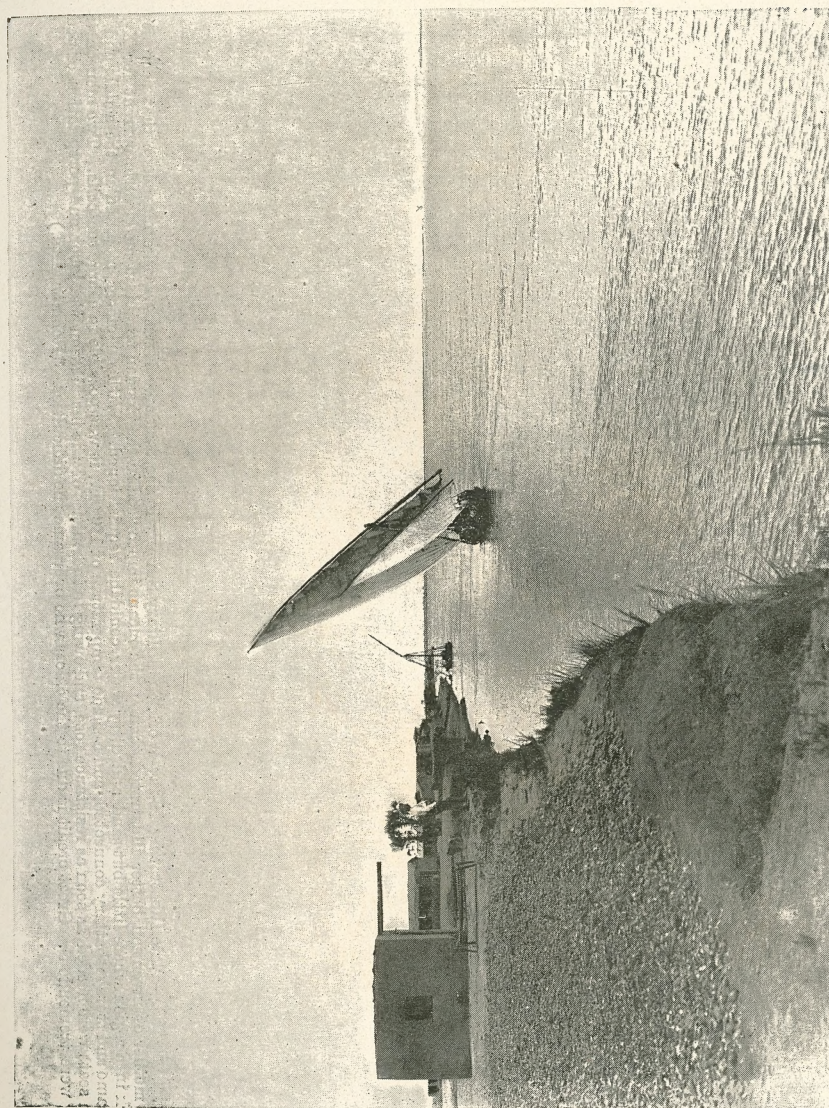


PLATE 101.—Illustrating Dr. Battersby's Work in the Soudan. This beautiful picture is of great historical and X-ray interest, for it shows the site of the pioneer invasion of radiography into the Soudan. At this point on the Nile, 1,250 miles from Cairo, in a region just rescued from dervishes, the first X-ray pictures ever taken in that part of the world were developed in Nile water looking like thin coffee, and the temperature 110° F. in the shade. Here was situated the advanced base surgical hospital and the headquarters for X-ray work in the Omdurman campaign. Of 121 wounded brought to this hospital after the battle 21 cases could not be accurately diagnosed by ordinary means. In 20 of these cases the X-ray found the bullet or proved its absence, and the 21st case was so ill at the time that he was passed. (Rebman, Ltd.)



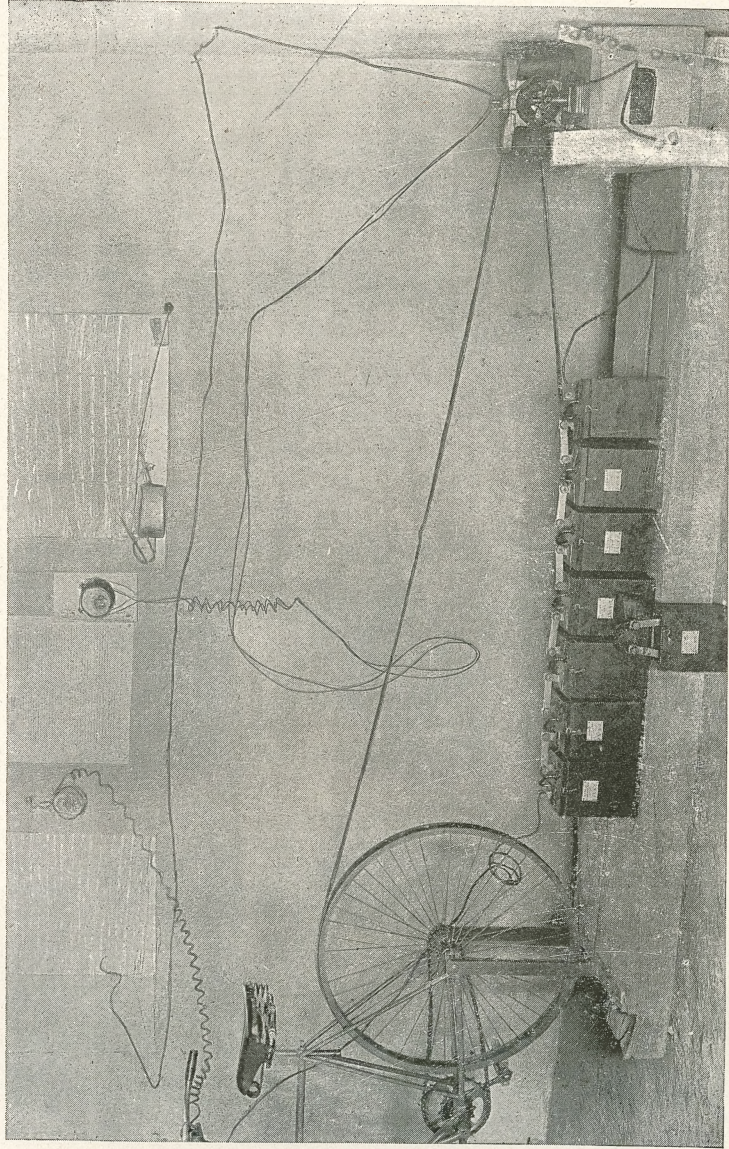


PLATE 102.—Plate Illustrating X-ray Work in Military Surgery in the Soudan. Never was the old adage that necessity is the mother of invention better illustrated than in the means improvised in the Soudan to obtain an electric current for X-ray work in a region where little but sand and dirty water could be requisitioned. With an officer mounted in the saddle and the dynamo and storage battery connected, and a shade temperature of  $110^{\circ}$  F., it was possible to charge the cells. Two men on tandem seats were needed as soon as resistance rose, and owing to infirmities of the installation the labor and perspiration of pedaling were tremendous. Great credit is due to the officer who overcame the difficulties. (Rebman, Ltd.)

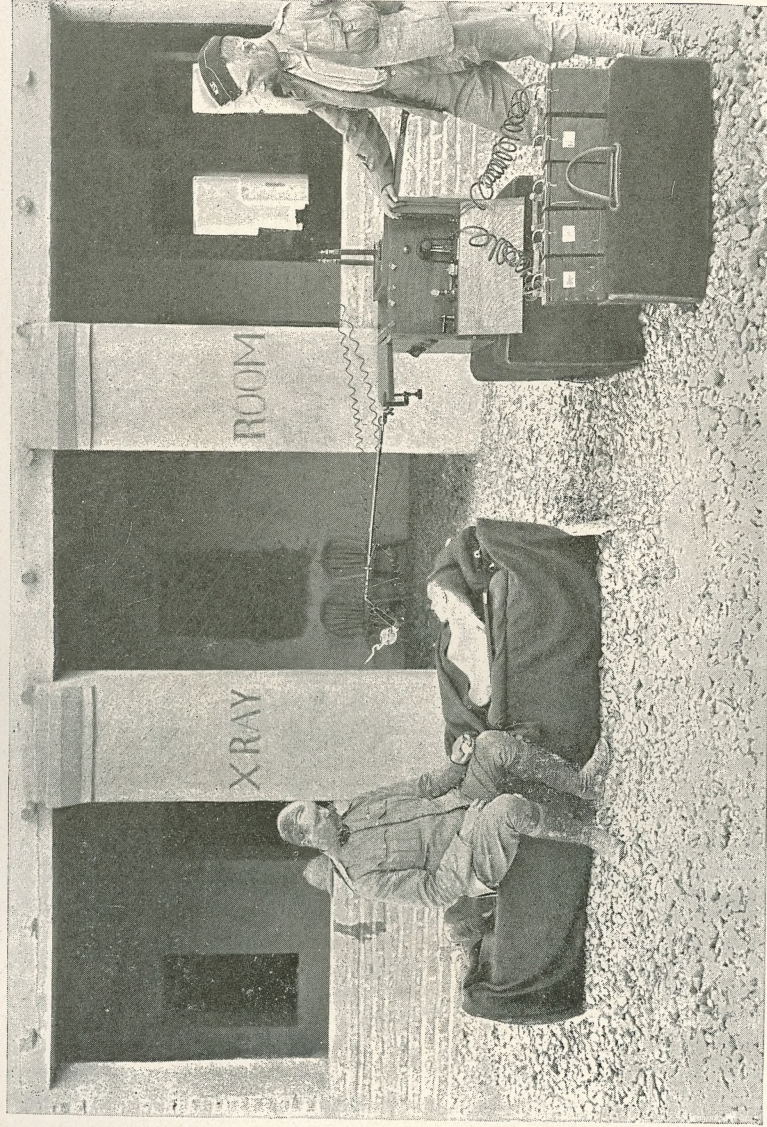


PLATE 103.—Plate Showing a Military X-ray Exposure in the Soudan. In this plate is shown the field 10-inch coil at work in the hands of Major Battersby and orderly. Some years hence this picture and its mates will be prized as history and deserve to be taken from perishable current literature and preserved for future readers as the author has done. (Rebman, Ltd.)



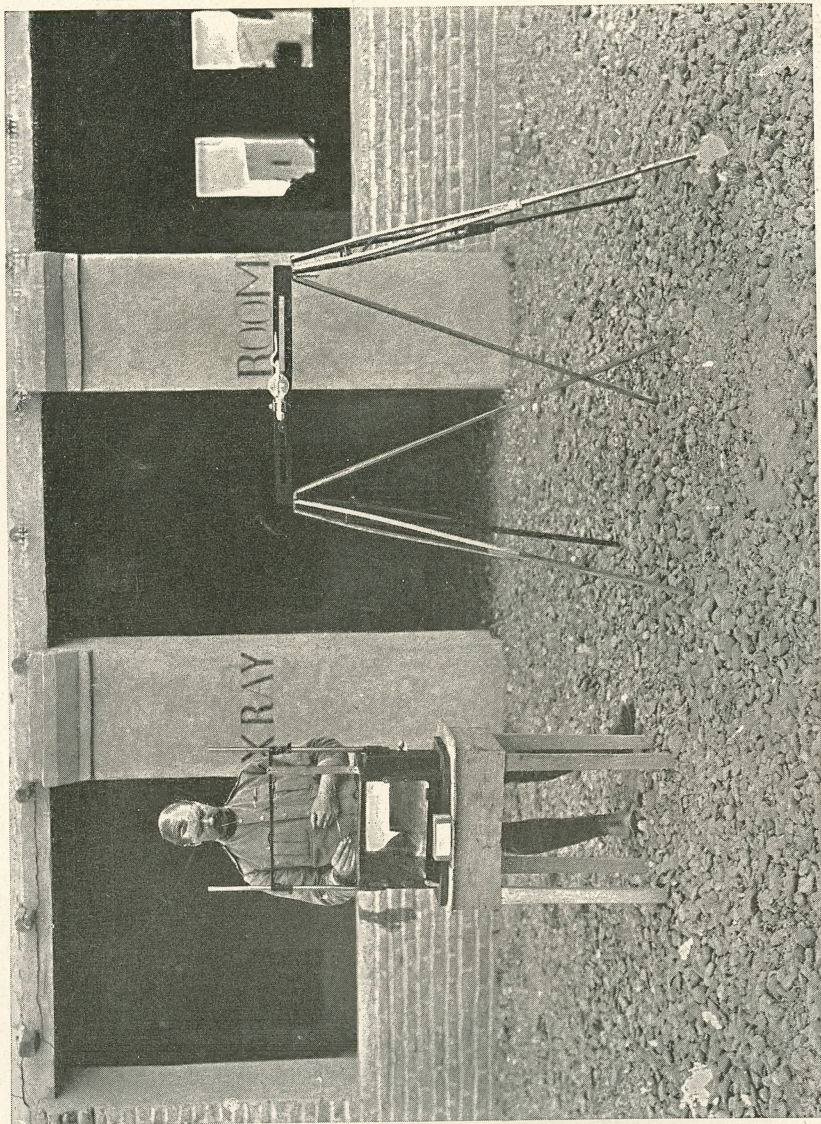


PLATE 104.—Plate Illustrating Localization of Bullet in Negative after Radiography. Here, on the banks of the Nile, is seen the localizing apparatus, a duplicate of which is possessed by the author and by the majority of operators who have done the finest work in this line. The same was employed in the Santiago campaign of our Spanish-American war, and in the war in South Africa. (Rebman, Ltd.)

"These cases are of special clinical value as they show that wounds made by the larger lead bullets, when uninterfered with and treated by occlusive dressing, are usually aseptic and run favorable courses.

"Wounds of considerable size, made by a .41 brass-jacketed bullet with a soft-lead core from the Remington arm carried by some irregular Spanish troops, were either originally infected or extremely liable to become so.

"In gunshot injury of the spinal-cord or brain localization of the lodged bullet will determine whether symptoms are due to the original traumatism or to pressure from the ball." [Three cases of marked clinical interest are reported in full, the X-ray guiding treatment.]

"Infection.—While all bullets which lodge would be more likely to produce infection in a wound than those which pass through, yet it appears from the records that *neither ricochet, passage through other objects, lowered velocity, nor contact with foreign matter, the possible carrying of shreds of clothing, etc., into the body, markedly affect the non-liability of the new missile to produce infection.* This is of clinical importance in putting all these wounds, unless manifestly infected, into the class of wounds best treated by occlusive dressings and *non-interference.* The same conclusions hold good for the older large lead bullets of low velocity, as has been stated.

**Localization of Bullets in Army Surgery.**—"The superiority of the X-ray over other methods of locating lodged missiles is so great that, when available, it should be used to the exclusion of all others. It is a most distinct aid to conservative surgery in that it usually obviates an immediate attempt to explore the track of the wound—a necessity before the wound closed, in the old times. The X-ray makes possible one of the great tenets of modern surgery—*non-interference.* The uncertainty and dangers of exploration through the wound are done away with by the certain and safe action of the X-ray, which can be employed at any favorable time.

[Impressive reasons are given at length why the probe in all its forms should be obsolete in favor of the less unreliable and less dangerous X-rays, but lack of space compels us to omit them here.] "Reasons given for X-ray localization, apart from X-ray determination of the presence of a bullet, take cognizance of the fact that lodged missiles frequently become encysted and cause no trouble, but, on the other hand, they may set up suppuration, or press on some neighboring nerve or organ, or may interfere with muscular action, or may cause pain. Moreover the knowledge of the presence of a bullet often creates mental disquiet and anxiety; in other cases it is important to know the exact location of the missile in order to determine whether the symptoms which follow are due to the lesions of transit or to irritation from the foreign body; or whether or not the symptoms may be due to something entirely disconnected with either. In such cases accurate localization is of the greatest importance and value from a standpoint of diagnosis and treatment. (Cases cited.) The X-ray also possesses great value in finding retained fragments of missiles which



have been unsuspected till continued suppuration prompts the search." The apparatus used in the army were cross-thread localizers and the fluorometer, the uses of which are both taught in this volume.

**"Gunshot Fractures.**—The results of X-ray examinations made during the late war lead to the conclusion that, minor differences apart, gunshot lesions of the shafts of long bones by small-calibre bullets may be divided into three main classes:

- "1. Fractures by bullets having sufficient velocity to perforate.
- "2. Fractures by undeformed bullets penetrating only.
- "3. Fractures by deformed penetrating bullets.

"X-ray examinations demonstrate that the effect of the modern small, jacketed bullet on the extremities of long bones is markedly different from its effect on the shaft. Owing to the difference in structure the comminution is never so great, and frequently the ball simply channels the bone, or, when nearly spent, embeds itself without any splintering or comminution. The same conclusions relative to treatment, as before stated, hold good in fractures both of extremities and shafts. Infection or non-infection indicates whether the wound should be treated expectantly or otherwise. Nor does the fact that joints are involved alter the rule of treatment. Infection or extensive destruction may necessitate operative interference, but with ordinary penetrating or perforating wounds occlusive dressings and immobilization have been followed by the best results."

A large part of the long report from which the above conclusions are taken is devoted to clinical cases in which the value of all the resources of X-ray facilities grows on the mind from sheer accumulation of the official evidence. Case after case shows certainty of procedure where without X-rays mistakes were unavoidable. One of our chief surgeons wrote within a year that "he knew of no definite addition to our knowledge of fractures or material modification of the general rules of treatment that had been contributed by the X-ray," but practically in the presence of a case the concrete satisfaction of possessing the X-ray outweighs all abstract theories that can be conjured up to deprecate it.

**The X-Ray in the Field in War.**—At the first hint of war after Roentgen's discovery it was assumed by writers that the X-ray would be a necessity in the *field*. The experience of the Spanish War and the war in South Africa has proved the contrary. In a personal letter from the War Department to the author we have been informed as follows:

"The only X-ray work done during the Spanish War was at base hospitals, such as Key West and on hospital ships. At these places the work was done under the same conditions of posing, apparatus, etc., as is common in city hospitals. There was no X-ray work done in the field, and, I think, fortunately so, for if such work were done



PLATE 105.—A Bullet Wound in Left Ankle Showing Bands of Lead Plaster. Bullet located and extracted. (Rebman, Ltd.)



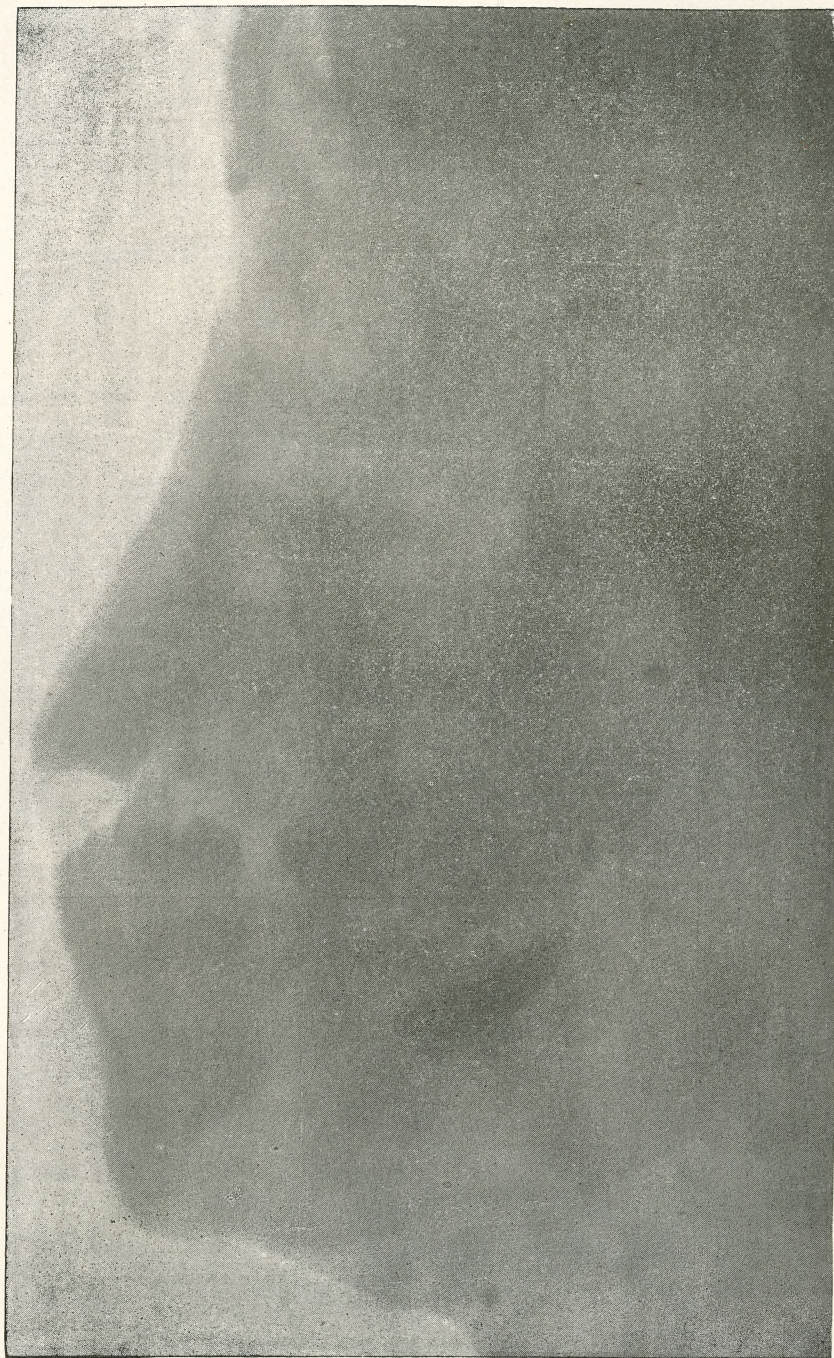


PLATE 106.—Radiograph of bullet located under left lower jaw; entrance wound on right side of neck; removed; jaw fractured; case from armored train disaster; exposure made by Lieutenant Bruce at Ladysmith.



PLATE 107.—This reproduction of a radiograph by Lieutenant Bruce shows a gunshot wound near the head of the radius with fracture of the lower end of the humerus and head of the radius. The casualty occurred at the Wagon Hill engagement, January 6th, 1900. (Rebman, Ltd.)



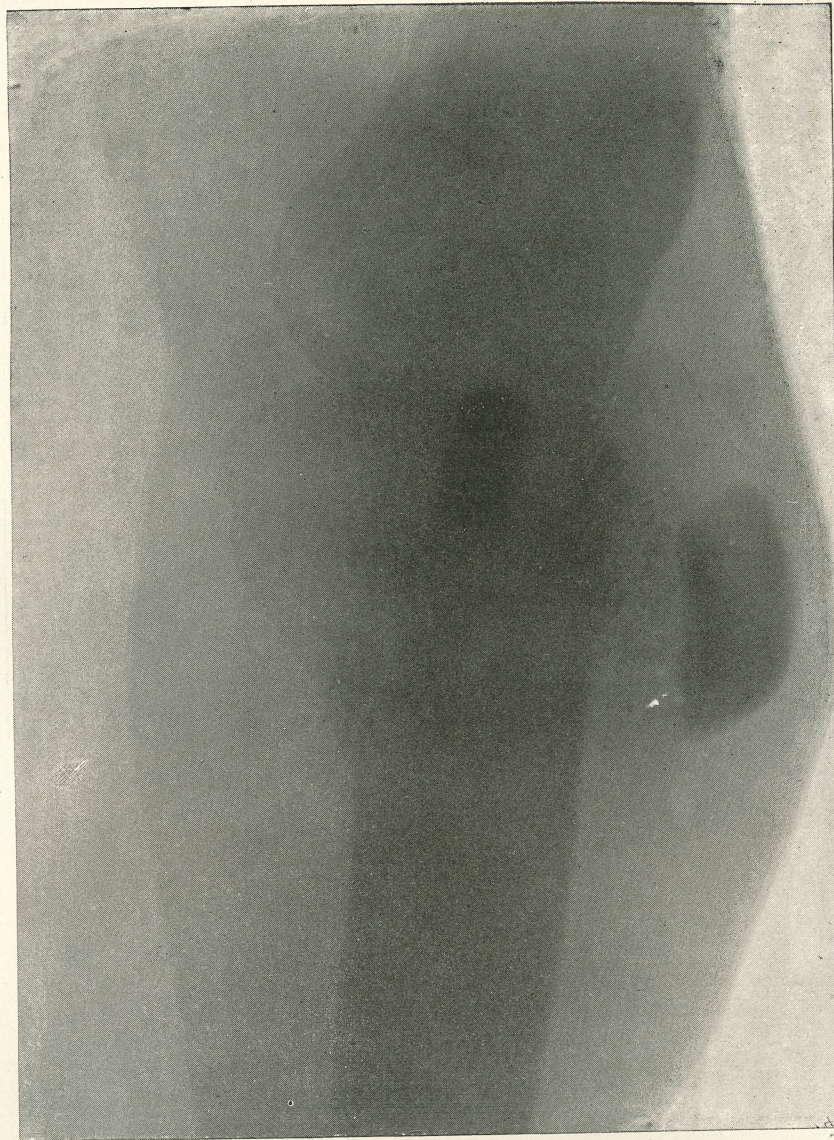


PLATE 108.—Bullet in knee. Side view. A private wounded in the Soudan. Bullet readily found and extracted. Localization in a case of this kind would be most readily accomplished by the author's "One-Minute Localizer," which requires no negative and but one posture of the part. (Rebman, Ltd.)

in the field it would tempt surgeons to operate without proper facilities for good results. On the hospital ships the surroundings were somewhat novel, but the X-ray work did not differ from that in a city laboratory."

The Surgeon General's report presents the official conclusions on the subject of the field use of X-rays substantially in the following manner:

"The many cases of lodged bullets, in which the bullets were left undisturbed till the patient reached a general hospital or hospital-ship where the missiles were located by the X-ray and removed under antiseptic technic with perfect safety to the patient and rapid recovery prove the non-necessity for the use of X-ray apparatus in field or other advanced hospitals. Infection is almost sure to occur from the almost absolute impossibility of obtaining asepsis under the conditions which are present at the front, and the recovery of the patient is delayed, and the function of the wounded part is likely to be impaired by the suppuration which will follow. Von Bergmann, who obtained such brilliant results in the Turko-Russian War, has expressed the opinion that the X-ray will prove a menace in military surgery if it is allowed to prove an incentive to unnecessary operative interference.

"Professor Kuttner, who followed the Greek War with the German Red Cross Society, states, as the result of his experience with X-ray apparatus in that war, that 'X-rays are of great importance in war, but only for fixed hospitals and those installed in fortresses, while for moving field hospitals their application is very limited.' Abbot also, in an article on Surgery in the Græco-Turkish War, says: 'The use of the X-ray becomes an impossibility at the actual front. Fortunately it is not needed there. In future wars the X-ray will be of the greatest value, but not at the fighting front.' He then formulates in closing:

"1. X-ray apparatus has no place on the field, where the detection of bullets can only be an incentive to premature exploration.

"2. The less wounds are tampered with before reaching satisfactory surroundings the better.

"3. The modern bullet is practically aseptic, and there is no urgency for its removal.'

"Surgeon Major-General Jameson, of the medical department of the British army, says of the X-ray in the Boer War: 'The place, I think, for X-ray apparatus is in the line of communication or at the base hospital.'

"Our experience in the war with Spain was fully in accord with the above opinions, as the use of the X-ray apparatus at general hospitals and on board hospital-ships met all practical requirements. As to the use of X-rays in gunshot fractures the same rules hold as for lodged missiles, to wit: occlusive dressings and non-interference at the field hospitals except when operation is imperatively demanded. Cases of gunshot fractures which can be benefited in any way by the



use of X-rays at the front, are extremely infrequent. Also, in considering where X-ray apparatus should be placed for military surgery in time of war the fact must be taken into account that the appliances are more or less bulky, heavy, and somewhat difficult to transport, and that their use requires considerable experience, and at field hospitals would necessitate taking time when surgeons are most busy with the work of active operations. These disadvantages might be disregarded were the benefits in field hospitals at all in proportion to the difficulties of transportation and use; but when the benefits to be derived apply to extremely few cases the surgery of the front can better be employed in other ways.

"In view of these facts it appears that the place for X-ray apparatus is at base hospitals, general hospitals, and hospital-ships, and that apparatus so located will meet all the requirements compatible with the conditions incident to the practice of military surgery. With apparatus so located X-ray examinations can be followed when necessary by proper aseptic or antiseptic operative methods. This plan was adopted in the Spanish-American War with the best possible results."

From the extensive use of X-rays in the South African War it has been the opinion of close observers that they have proved to be *indispensable*. At a comparatively early date in the war the British Government supplied seventeen ten-inch coil equipments for this service, and the greatest experience so far gained in military work has been with these apparatus. A number of official reports suggested improvements; and the place of X-rays in military surgery, and the manner of equipping mobile and base hospitals has been now settled by the combined experience of four wars. Recent revolutionary improvements in storage batteries lessen a serious difficulty of current supply for mobile operations, and if no current is wasted in needless ways a single charge will last a surprisingly long time. The following extract from Catlin's report gives an excellent idea of the range of cases in war practice:

"The cases usually met with consist, in the main, of retained bullets and fractures, though a few cases of traumatic aneurism, periostitis, necrosis of bone and the like, occur. Retained bullets are found in all parts of the body and *can usually be detected with the fluoroscope*, though it is necessary now and then to take a skiagram.

"*The approximate location of the bullet once made out exact localization presents no difficulty, either by means of the localizing apparatus, or, where possible, by taking an antero-posterior and a lateral view.* A short exposure of about four minutes for the thick parts and less in proportion for other situations, seems to give the best results.

"In using the fluoroscope a wide search is often necessary. One patient had a wound of entry just internal to the acromion process

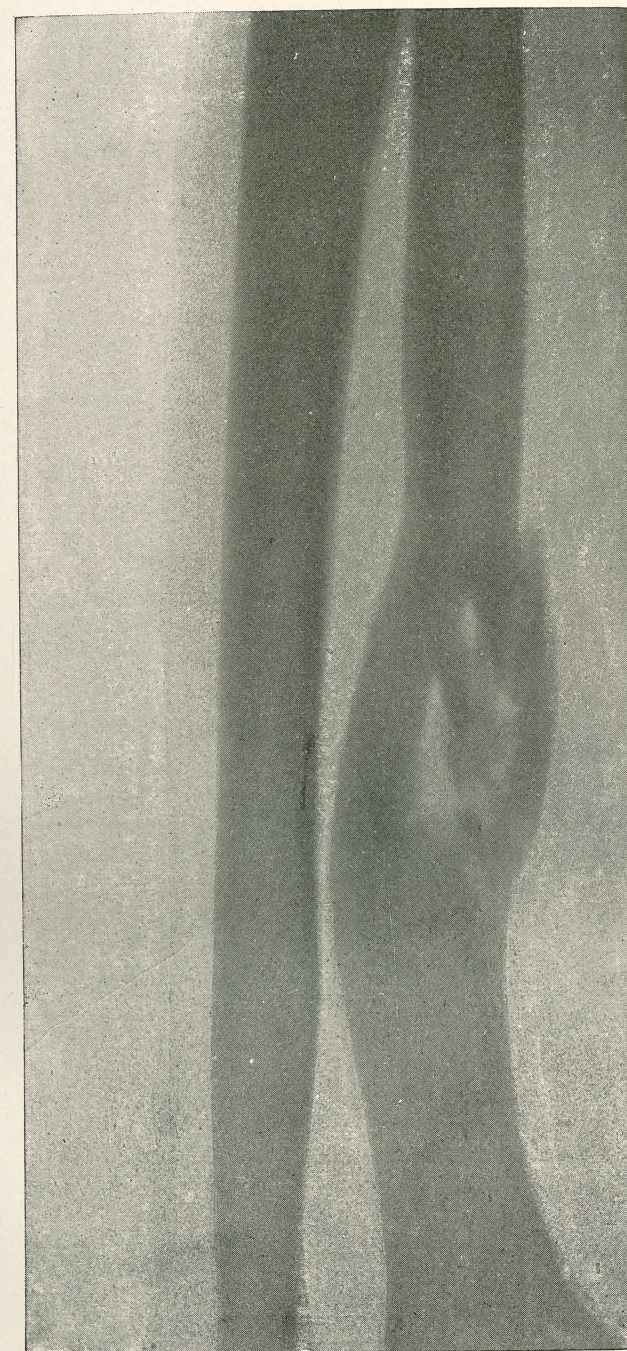


PLATE 109.—A bullet wound in the forearm from the battle of Modder River, South Africa. (Rebman, Ltd.)



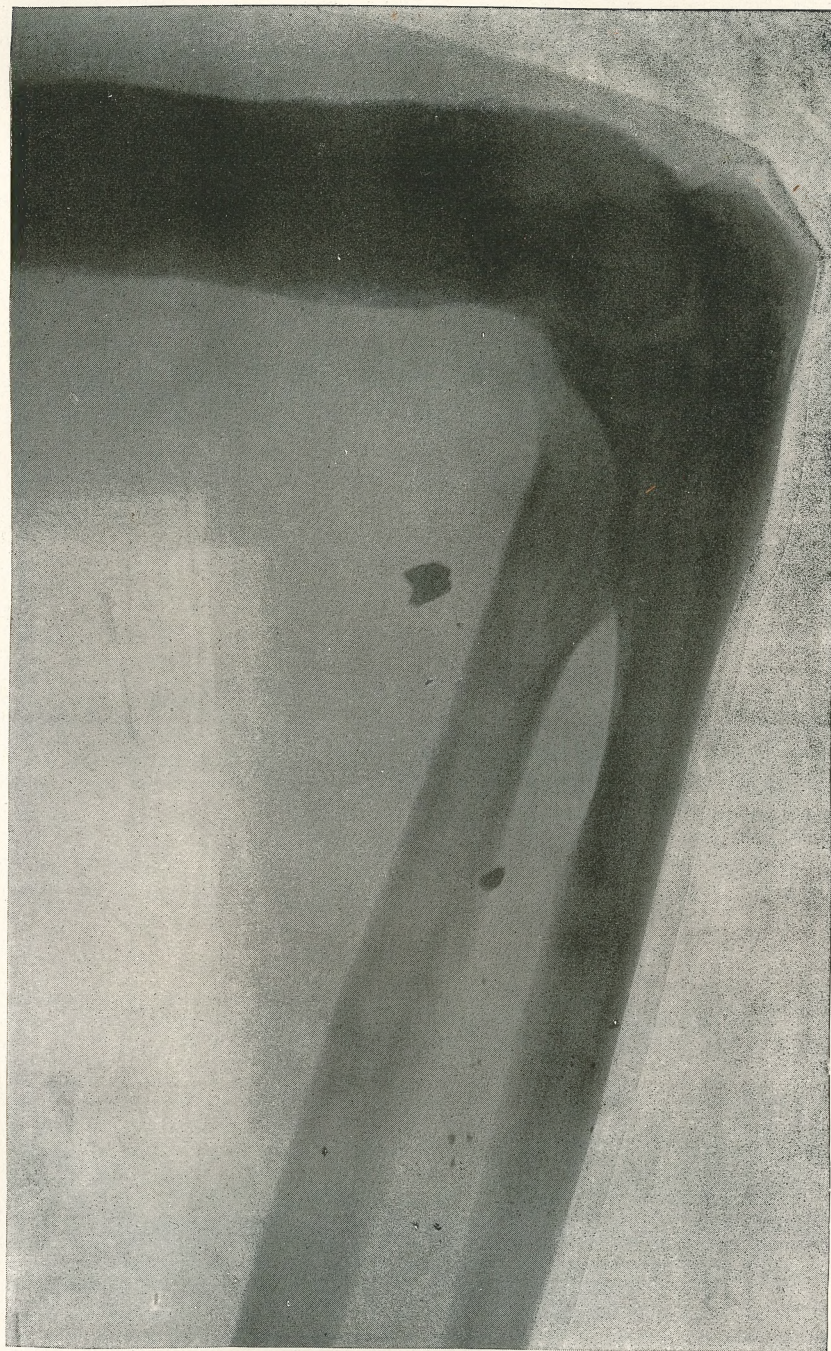


PLATE 110.—Splattered Fragments of Lead in Forearm. Minute fragments of shell in the forearm, with periostitis of the humerus. Wounded at Spion Kop, Boer war.

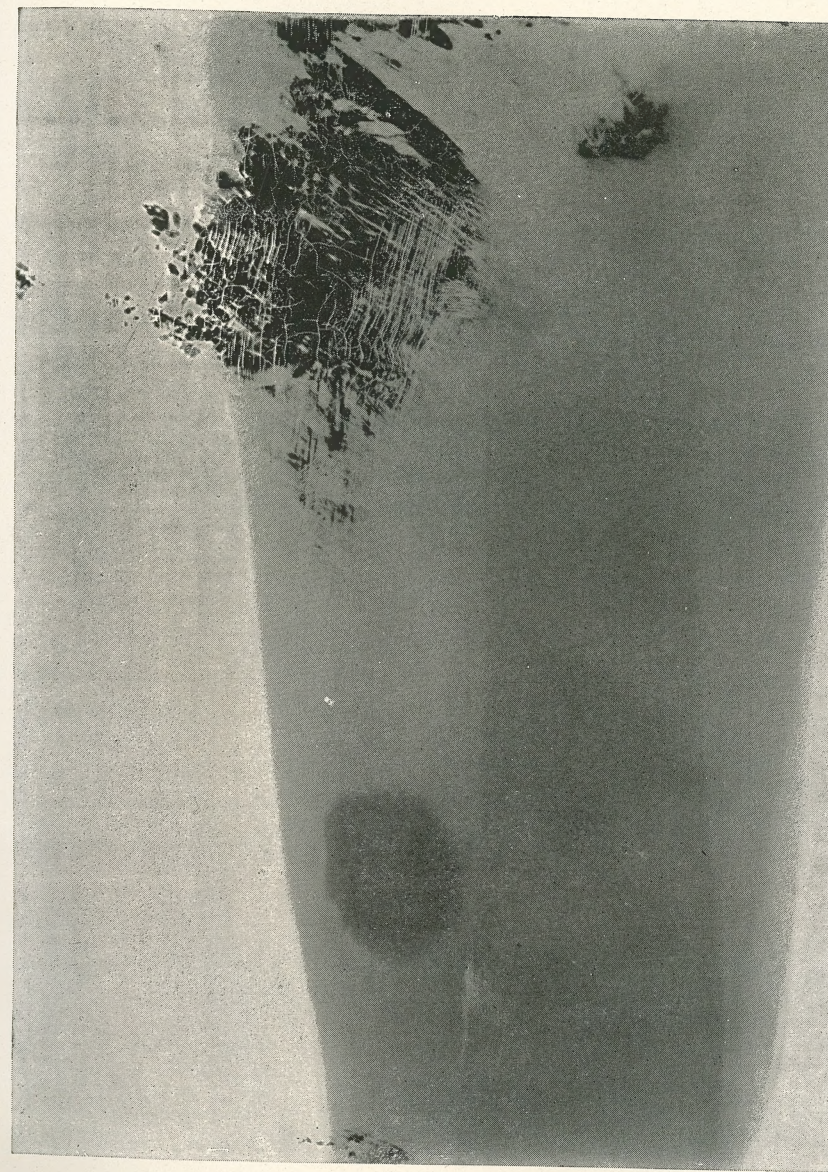


PLATE 111.—This plate shows a bullet in the thigh, but the mass at the upper portion of the print is not a splattered shell. It is dust on the plate and invites attention to the fact that in the interpretation of X-ray photographs the physician's pre-exposure knowledge of what ought to appear in the negative is necessary for the elimination of extraneous shadows. Not even the best expert can fully interpret all the shadows of a plate except in the light of much collateral information.





PLATE 112.—This plate illustrates a gunshot shattering of the upper third of the right femur of an officer of the Imperial Light Horse at the battle of Elandslaagte, in the Boer war. Recovered and returned to duty without amputation. The picture was taken by Lieutenant Bruce. (Rebman, Ltd.)

on the right side. There was considerable bruising down the inside of the right arm and slight bruising of the chest-wall on the right side, but no bullet could be found in the arm or thorax. On examining the body further the bullet was seen lying just above the right great trochanter. There were no symptoms indicating that the bullet had penetrated so far. In another man the bullet entered on the right side of the thorax about four inches below the axilla after passing through the right arm. It was found lying close to the axillary-wall of the thorax on the opposite side.

"A number of patients brought up for examination had what looked like a Mauser wound of entry but none of exit. The symptoms were very like those of a patient with a retained bullet. The fluoroscope, however, failed to show the presence of a bullet, but on taking a skiagram a fragment of bullet little larger than a pin's head was detected. All the patients agreed in saying that the impact felt like the blow of a sledge-hammer, an expression used by patients hit by bona-fide bullets. These fragmentary wounds were supposed to occur from bullets striking a stone and the pieces flying in all directions.

"Out of nearly 400 cases examined here so far the majority are cases of fracture. The difference in effect of the impact on different bones is striking. As a general rule, where there is compact bony tissue more or less comminution occurs. Where cancellous tissue is struck the action is one of simple penetration. In all cases the first action of the bullet seems to be one of penetration; the differences occur after that. Usually in the shaft of a long bone four lines of fracture radiate from the hole first bored, separating the bone into four fragments. These fragments may then break up into smaller ones still, the sizes of which vary with the range—very small fragments at short ranges and larger fragments at longer ranges."

As has been ably expressed by a prominent authority, "The X-rays have furnished the army surgeon with a probe, which is painless, which is exact; and, most important of all, which has aseptic qualities not possessed by the older though ingenious instrument bearing Nelaton's name." In Sudan the conclusion from all observations was this: that each case had to be studied as a special problem with regard to the intelligent adaptation of detail and X-ray method to be employed. A routine system is impossible. "The accurate localization for practical surgical purposes of foreign bodies in the tissues is," says Major Battersby, "the consummation of skiagraphic art. A bullet, for instance, in a loaf of bread can be localized with a fluorescent screen by means of acupuncture needles, but such a procedure is scarcely applicable to patients suffering more or less from shock and in a depressed and nervous condition." Our chapter on Localization teaches the essential methods.

Senn's opinion of the value demonstrated by the X-ray in military



surgery has been given various and wide circulation in medical journals, but the permanent record of a few of his remarks should be made in a work of this kind intended for the physician's reference library. As Chief of the Operating Staff with the Army in the Field during the Spanish-American War Senn has written:

"The X-ray has fully answered expectations in military surgery as a diagnostic resource. It has fully demonstrated its great value in military surgery. It may be relied upon in locating bullets in almost any part of the body, and in ascertaining in doubtful cases, existence, location, and nature of fractures, and in determining the exact location of the fragments. All this may be done without pain and without subjecting the wound to additional sources of infection. No ill results followed the exposure in any of the cases.

"The probe, so constantly relied upon in the past in locating bullets, is an instrument of uncertain diagnostic value, and its use is always attended by more or less risk. Modern military surgeons have formulated a rule which should never be ignored, *never probe a recent bullet-wound*. The probe is as objectionable in the examination of a compound fracture as in exploring the track made by a bullet. The X-ray has a great feature in this part of military surgery. The skiagraph enables us to diagnose the existence or absence of fracture in a large number of doubtful cases in which we had to depend exclusively on this diagnostic resource. In fractures in close proximity to joints it has been of the greatest value in ascertaining whether or not the fracture extended into the joints.

"The X-ray also proved of the greatest practical utility in showing the displacement of fragments in gunshot fractures of the long bones, which enabled the surgeons to resort to speedy measures to prevent vicious union. The fluoroscope has greatly enhanced the diagnostic value of skiagraphy in military surgery. In the light of experience the X-ray has become an indispensable diagnostic resource to the military surgeon in active service, and every chief surgeon with every Army Corps should be supplied with a portable apparatus and an expert to use it."

## CHAPTER XXXI

### X-RAYS IN ORTHOPEDIC SURGERY

SURVEY OF PRACTICAL USES. DIAGNOSTIC IMPORTANCE AND SCOPE. NEED OF BINOCULAR VIEWS IN THIS FIELD OF WORK. HINTS IN TECHNIQS.

How great may be the appreciation of X-rays among the general body of orthopedic surgeons cannot be stated, but the scientific and practical value of X-rays in the study of congenital and acquired malformations of the bones would appear obvious. Certainly, if anybody can use X-rays to advantage, it would seem that the specialist with orthopedic practice would find them indispensable. Some of the best and most brilliant radiography yet seen has indeed been done by surgeons in this branch of work, and among them, speaking not from theory but from experience, are men who assert that skiagraphy of the extremities especially has given more valuable information than dissection. The exact anatomical diagnosis which it enables them to make not only defines often the indications for surgical interference, but may also outline the technique beforehand. A dozen names may be mentioned which furnish most brilliant testimony to recent progress in this direction.

But nowhere is seen to worse advantage the limitations of the plane X-ray picture which is the mediocre routine of present methods. The literature of the subject for 1896-99 comprised fully 100 articles, but so far as we are aware all of them dealt with the one-focus radiograph which looks at the part as with a single eye. The superiority of binocular exposures, giving in stereoscopic view the true form, proportion, position, shape, relation, and body of the part instead of a plane shadow without perspective, would be apparent to any orthopedic surgeon at the briefest glance. The fluoroscopic binocular view has a great field here, and if now available in practical form would make obsolete all that has been written of plane pictures, and the radiographs of the past five years would be consigned to the waste basket. For further information on this point see section on Stereoscopic Radiography; also the Stereoscopic Fluoroscope.

With the remark that much that is said about "misleading data"



and of the difficulties of interpretation refers only to plane radiographs without "body" and does not apply to the far clearer diagnostic pictures made with stereoscopic effects, we select for our instruction two short summaries by skilled men. The illustrations are omitted as cuts of radiographs are unsatisfactory.

Lovett thus writes of the use of the X-ray in orthopedic surgery:

"It is too early in the history of the X-ray to yet speak definitely of its full value or its full possibilities in diseases of the joints. But at the present time it possesses very great value, and in certain cases is indispensable in this branch of surgery. This condition of affairs is so well recognized that many orthopedic surgeons make it in certain cases a part of their routine examination. In general, its use enables us to determine the existence and character of congenital and acquired bony deformities and malpositions. It often aids in the diagnosis of joint disease, especially in tuberculous lesions. It assists when necessary in determining the relations of the bones after operations on the joints; and it enables us to study the history of progressive destructive disease of the joints.

"These are the most frequent practical uses of the X-ray, yet nowhere must the evidence revealed by it be interpreted with greater care and accuracy than in this department of surgery. It is easy (in single-plane views) to see too much or too little and to draw too definite conclusions from yet inadequate experience. At times certain pictures give data that are altogether misleading, but greater practice in technic will lead to better pictures. For instance, an apparently normal radiograph may be obtained in the case of a joint in which tuberculosis is sufficiently active to create serious symptoms. In Fig. 1 is shown the radiograph of the knee of a woman aged thirty-five, suffering for many months from an acute, painful affection of the right knee-joint. Tumor albus with abscess had occurred in childhood, and a useful, although flexed and partly immovable knee had resulted. The question as to whether the condition existing recently was due to recurrent tuberculosis or not was most important. The radiograph showed a femur irregular from the destruction of the early disease, but apparently perfectly definite in outline and lacking those characteristics to be described as significant of joint tuberculosis. The symptoms demanded operative interference, and, on opening the joint, an acute state of inflammation was found, and the lower end of the femur was extensively eroded by recent tuberculous foci.

"Fig. 2 shows the same knee in front two months after excision, demonstrating the current position of the bones from that point of view. The estimation by X-rays of the relative size of bones and the relations between them must be accepted with great reservation. The data afforded by such radiographs are of value only when the relation of the tube and plate are regulated with correct accuracy. It is easy to produce obliquity of some shadows by a very slight slant of the axis of the rays and very little inaccuracy in this respect on the part

of the operator is needed to produce considerable variation in the radiograph."

[Students of this course are fully instructed how to obviate all the above difficulties, and especially to rightly estimate at a glance the relative sizes of bones in all X-ray views of them. The principle is simple and direct.—ED.]

"Attempts are sometimes made to demonstrate atrophy of one side of the pelvis in hip disease, elongation of one patellar ligament by comparison with the well side, atrophy of one femur as compared with the other, and similar conditions. Success depends on individual conditions and exactness in technic.

"My experience has been mostly with the Static machine driven by a motor and direct 110-volt street current. The highest and best tubes procurable have been used. For the present purpose it is perhaps best to consider not so much what the most experienced observer can see with the best possible apparatus under the best possible conditions, but rather what the average surgeon may expect to see after some experience with such apparatus as he might reasonably have in his office. The photographic plate as a rule, of course, gives the best and most definite information, and often demonstrates conditions which are overlooked with the fluoroscope. A noteworthy instance of this is found in exostoses of the bones of the feet, where exostoses of small size are almost sure to escape detection with the fluoroscope, while in the negative they are easily seen.

"On the other hand, in certain cases fluoroscopic examinations show the most, as for example when it is desired to see the head of a bone in more than one place, as in estimating the relation of the component parts of a joint. For instance, the fluoroscope was more useful than any radiograph could have been in demonstrating the position of the head of the femur in an obscure case of anterior congenital dislocation coming under the writer's observation, because it was possible to watch the head of the femur while the leg was manipulated.

"To secure definition of bones in the radiograph considerable distance between the tube and the part is most important. Twenty inches is a good rule. In the case of young children, and especially infants, the transparency of the epiphyses is an obstacle in many instances to obtaining satisfactory information from the X-ray. The radiograph of the foot of a child of three years old shows the condition at that age. The next radiograph, the foot of a child of seven, shows the ossification at that age. The knee (Fig. 5) of a child of two years makes it very evident that very little is to be seen of the joint surfaces at that age, at least without securing a more differential radiance than the high tubes here used. In one knee may be noted a scarcely perceptible haze due to an acute traumatic effusion, an appearance to be spoken of later. Clearly marked epiphysal lines are seen in the healthy knee of a boy of eleven (Fig. 6), and up to the age of puberty the tubercle of the tibia may often appear to be detached.

"Separation of the epiphysis, however, when it is ossified suffi-



ciently, is easily detected by the rays. In our next picture a boy, after a fall of moderate severity, developed swelling and stiffness of the knee-joint, which, when seen six weeks later, was diagnosed as probable tumor albus after a careful examination. The real state of affairs was made evident at once by an X-ray examination. Congenital bony deformities, absence of bones, and similar conditions can, of course, in children of sufficient age be demonstrated with X-rays. Its most frequent usefulness in this connection to the orthopedic surgeon is in furnishing data, perhaps not obtainable otherwise, in cases of congenital dislocation of the hip. Here it is possible to confirm or establish the diagnosis and after operation to demonstrate the reduction of the head of the femur. It is also possible to differentiate in this way (in doubtful cases) between fracture of the neck of the femur and chronic disease of the hip-joint.

"Coxa vara may be recognized in radiographs. In diseases of the joints the X-ray is most useful in furnishing diagnostic information often not obtainable by other means. Synovitis, if of sufficient degree, is made evident by an increasing resistance to the passage of the rays which surrounds the ends of the bones with a slight haze in the negative. There will be seen no loss of bony outline, but simply less distinctness than normal. In the fluoroscope the bones fade in dark, clean-cut outline toward the joint surface, which should be distinct. In tuberculosis of the joints it is generally agreed that small foci are not, as a rule, to be distinguished in radiographs. Later in the disease, however, an appearance more or less characteristic is to be seen in the disappearance of the shadow of the articular end of one or both bones. In a negative strong enough to give a definite outline of the bones forming a joint it is very suggestive of tuberculosis or *some process destructive of bone* to find a place where the outline of bone disappears, and is replaced by an indefinite cloudy appearance.

"In Fig. 16 is shown the radiograph of a case of hip-disease three weeks after excision. The radiograph before excision was similar to Fig. 18. Before it was taken a solution of one part of bismuth and two parts of glycerine was injected into the sinuses to demonstrate their course and extent. The irregular dark areas are due to this injection. This method will be found useful in shadowing the course and extent of sinuses and abscess cavities.

"In acute infectious osteomyelitis the destruction of bone may be identified and negatives present much the same cloudy appearance as in the acute stage of tuberculous disease. Separation of the epiphyses may be identified as well as thickening of the upper part of the femur. In Charcot's disease we can identify bony destruction and displacement. In a case of the elbow the question of diagnosis between sarcoma and Charcot's disease was only made clear by the radiograph. In arthritis occurring in the joints of bleeders Fig. 22 and 23 show two cases under my care. In both the joint inflammation was active when the exposure was made. One shows only a

dark shadow around the ends of the bones, while the other shows nothing definite. Gocht has described from two cases which he radiographed certain definite appearances, such as atrophy of the femur, irregularity of the epiphyseal line, disappearance of the normal joint cleft, broadening of the intercondyloid eminence of the tibia, etc. The same dark cloud is apparent in his pictures as in mine.

"In rheumatoid arthritis, exostoses are rarely identified; changes in the shape of the articular surfaces of the bones are to be seen when they are present; diminution or increase in the ends of the bones may be appreciated, and atrophy and destruction of cartilage is made evident by a disappearance of the normal cartilaginous spaces, shown in the radiograph by apparently closer contact of the bones with less space between them.

"Fig. 25 shows the radiograph of a case where the diagnosis was in doubt between chronic rheumatic and chronic tuberculous disease of the wrist. The radiograph showed a clear bony outline, and inoculation from the fluid of another joint in the same patient was negative as regards tuberculosis.

"Fig. 26 is the radiograph of an adult patient with severe gonorrheal arthritis of the wrist, showing an indistinct area corresponding to the carpal bones, which should be separate.

"In certain obstinate and painful cases resembling flat-foot, the X-ray serves to demonstrate the existence of spurs of bone running from the under surface of the back of the os calcis, and sometimes from the back of the upper surface of the same bone. This information is not to be obtained by other means, and is most important in the matter of treatment and prognosis, which is in such cases discouraging. They may be identified when hardly larger than a big surgical needle and not over a quarter of an inch in length, and from this stage they apparently grow larger until they reach the size shown in Figs. 27, 28, 29. They occur in connection with gonorrheal rheumatism, rheumatic gout, and in certain cases where no etiologic factor is apparent.

"This paper leaves out the consideration of many conditions as important as those mentioned in this connection, but it has seemed best to the writer to dwell chiefly on those conditions in which the X-ray in his *personal experience* had proved most often of practical use; and conditions in which its conclusions might be open to question, or in which the necessary information might be obtained by other means, have been avoided.

"It may be proper to add that none of the writer's radiographs shown have been in any way retouched or manipulated—a process always open to question."

Says another orthopedic surgeon:

"The age of the patient is no bar to the use of X-rays. The youngest subject exposed by myself was an infant seven days old. Radiographs of this case show the existence of double equinovarus,



genu recurvatum, dislocation of one hip, and a club hand. Within the past few years congenital dislocations of the shoulder have been more generally recognized. When there is any doubt as to the condition of the joint the X-ray furnishes a ready means of making a positive diagnosis. In lateral curvature of the spine the X-ray enables the surgeon to note the degree of bony distortion, and to determine whether a given plan of treatment has any decided corrective action on the malformed vertebrae. A radiograph will probably be found more reliable than any system of tracings and measurements, as it shows the bones unobscured by the soft parts.

"It frequently happens that slight injuries in the neighborhood of joints produce symptoms that are somewhat obscure and tend to mislead the surgeon. A radiograph affords a means of removing any question of doubt, so that appropriate treatment may be instituted. The case illustrated in Fig. 10 is that of a lad about fourteen years of age, who received an injury to his right leg in a football game. He was disabled for some weeks, and when first seen by me, about two or more months after the injury, he was still suffering from pain and inability to get about without limping. A radiograph made at this time showed that the tibial tubercle had become separated and was still ununited. Under treatment, the symptoms rapidly disappeared, and a few weeks later union had taken place, as proven by another radiograph. Fig. 11 is the normal knee of the same subject. By comparing the two figures the pathologic condition may be appreciated.

"The text-books on surgery dismiss the subject of fractures of the tarsal bones, other than the os calcis and astragalus, with the statement that they can hardly occur except from crushing force. One author says: 'I have never seen such a case except when the whole ankle was crushed.' In the light of modern methods of examination, however, it is proved that this statement is erroneous. In a case that recently came under observation, and which had been treated as a severe sprain for four months, it was found that the patient in simply alighting from a 'buck-board' had sustained a fracture of the scaphoid. Other similar instances might be cited.

"The elbow- and shoulder-joints are particularly exposed to slight injuries, that end in serious disability if not in complete ankylosis. The importance of exact diagnosis cannot be overestimated, for the success or failure of treatment must depend upon it. Slight fractures into or in the neighborhood of joints cannot always be determined with any degree of accuracy even by the most skilful surgeon; as crepitus, etc., may not be elicited. A radiograph, however, may be relied upon, if the precautions referred to in a previous section are resorted to. In one case of marked disability after an injury to the shoulder, where several competent surgeons failed to determine the condition of the bony structures, a radiograph revealed a fracture of the acromion process. In another case of partial ankylosis of the elbow, an X-ray examination demonstrated an apparently insignifi-



PLATE 113.—This Instruction Plate shows adjustment of Author's Examining Frame with ankle-joint engaged in the field of axis-rays. The examiner sits in front with screen clamped in place. It is removed in the plate to show position of tube, the anterior and posterior vertical guides in line and making only one shadow, and the relation of foot to the markers. Note that though the frame is slightly tilted to suit the comfort of patient, yet the correct axis of the rays is maintained. The boy is an orthopaedic case, and the white line along the leg is not part of the examining-frame, but a metal brace which he wears.





PLATE 114.—For practice in interpretation study this picture as it is, and then look at it in a mirror with a good side light. The mirror shows it to be a right hand exposed palm down and the deformity is much better studied when the normal position is restored to the observer's eye.

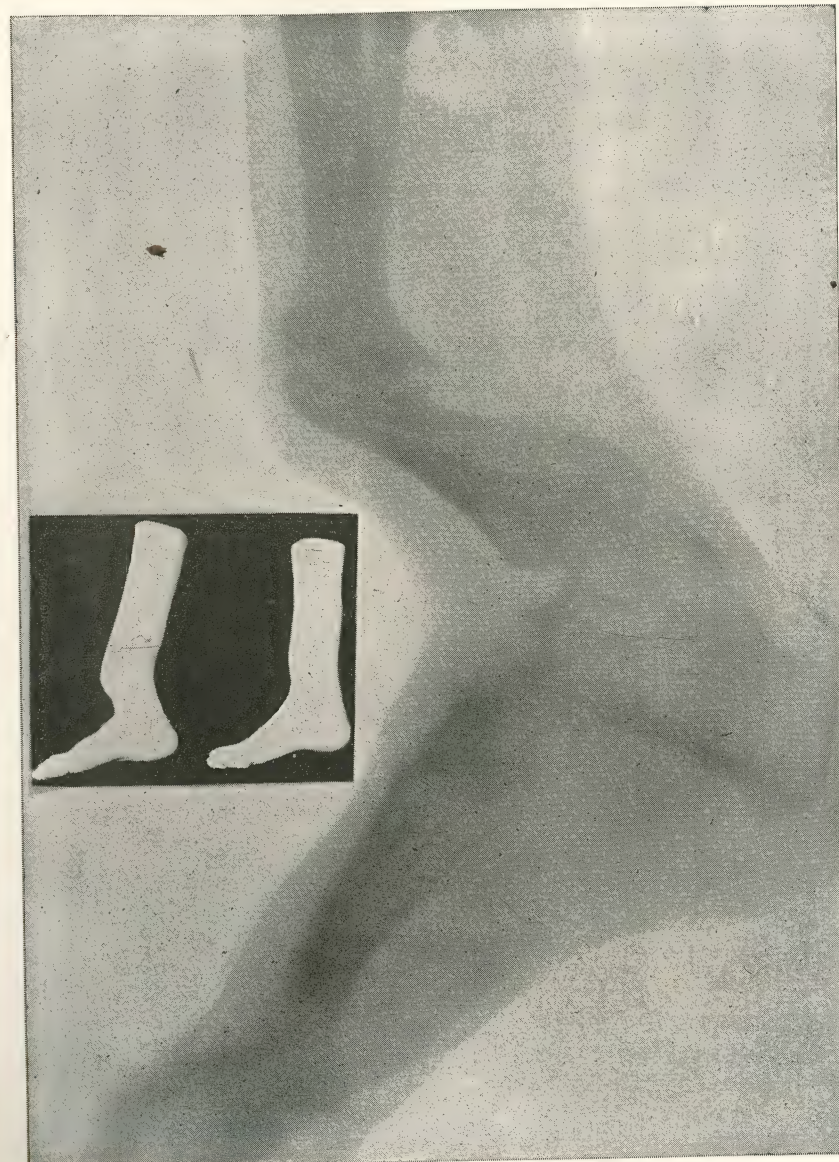


PLATE 115.—A case of false joint and deformity of leg. Age twenty-two. No pain. When three years old the child could run about quite well, and it is suspected that she then sustained a green-stick fracture which was neglected and did not form a complete osseous union. After the X-ray picture revealed the condition of the bones, an operation resulted in a useful limb. The cast shows the leg after treatment, but a second skiagraph is not available to show the actual state of the bones. (Rebman, Ltd.)





PLATE 116.—A gouty hand. Five seconds exposure. When this picture was taken with five seconds exposure the hand was first protected by heavy sheets of zinc till the tube was excited to its best efficiency. Then the zinc was suddenly withdrawn for the exact exposure-time and quickly replaced to cut off the rays abruptly as the tube was stopped. Variations of this plan have been used for other purposes. If it is desired to hold back the action upon the fingers so that the bones of the carpus may receive sufficient exposure a layer of zinc over the fingers during the first half of a normal exposure accomplishes the result. The mere hint will suggest special applications to the operator.

cant fracture of the olecranon as the primary cause of the restricted joint-motion.

"The condition of an elbow illustrated in Fig. 12 is of interest, as it shows the result of a severe fracture of the condyle of the humerus and of the radius and ulna, and demonstrates the cause of the existing disability.

"The value of radiography in deciding upon the advisability of operative or other interference in old bone-injuries, is perhaps not sufficiently appreciated. Patients might frequently be spared the use of the knife, and the surgeon relieved of the disappointment of a useless operation, by availing himself of this aid to diagnosis. This is well illustrated in Fig. 14, which shows a fusion of the patella and femur with fibrous ankylosis in the knee-joint proper. It would have been useless to attempt *brisement forcé* for restoring motion, with the patella and femur so firmly united.

"The differential diagnosis between true and false ankylosis is generally easily established by the ordinary methods of examination. When, however, the fibrous bands are very short, permitting no appreciable motion, some reliable means of differentiation becomes a necessity. A radiograph settles this question beyond any doubt.

"The value of radiography is fully established; it only remains to develop it to its highest possibilities, which must be accomplished by those operators who are willing to devote sufficient time and energy to the study of the subject, and become masters of this new art."



## CHAPTER XXXII

### STUDIES IN THE X-RAY DIAGNOSIS OF CALCULI

At a time scarce half a year ago, when the majority of active surgeons could not pose a patient nor place a tube for such a diagnosis, the editor of the *Archives of the Roentgen Ray*, himself an expert, wrote these words:

"It is difficult to place too high an estimate on the value of the X-rays in this particular branch of surgery. Exploratory operations for stone in the kidney may now be regarded as things of the past. Not only can a calculus be detected before it has reached any considerable size or has destroyed any large portion of the renal substance, but its exact location in the kidney can be shown beforehand so that it can be removed with the minimum of disturbance."

The scattered abstracts of current medical literature are lost to the surgeon who wishes to read up the subject and a composite gathering of facts in permanent record will here furnish a great deal of necessary instruction. For much of the material which we have revised in compact form we are indebted to Leonard, who has devoted special attention to this technic.

"The development which has recently taken place in methods of physical diagnosis greatly facilitates the differential diagnosis of renal disease, and pathologic processes in other organs can be readily excluded. The centrifuge, the segregator, the urethral catheter, and the cystoscope, are factors which have aided greatly in this development. Added to these is the X-ray. The X-ray method of detecting or excluding calculi in the kidneys and ureters has proved itself to be absolutely accurate when applied with requisite technic. The errors which have been noted have all been due to defective technic or to inexperience in reading the negative. The absolute *negative* as well as the absolute *positive* diagnosis of calculous disease is demonstrated.

"The advantages which this method possesses are its mathematical accuracy, and comprehensiveness; the equal value of the negative and positive diagnosis; the ability to detect calculi in their incipency before serious injury has been done to the functional efficiency of the kidney, and when the freedom from infection makes an

acceptic operation possible. The dangers that threaten when a small quiescent calculus is present can thus be avoided, as well as the dangers of operating upon the wrong kidney; or upon one without knowing that the other is the seat of calculus; or of leaving a calculus behind by an incomplete operation. The operative interference is localized and limited to a very small area, facilitating the operation and avoiding needless injury and traumatism to other portions of the urinary tract. Thus a calculus weighing forty-two grains was located in the upper pole of the kidney and removed through a small incision directly down upon it, that barely admitted a finger. A small ureteral calculus was located just within the pelvic brim, where it was found by bimanual palpation. It was removed by a transperitoneal ureterolithotomy, and proved to be a uric-acid calculus of the mulberry type which weighed two and three-fourth grains. A second ureteral calculus was removed per vaginam. A ureteral catheter was introduced and the vaginal wound packed; both packing and catheter were withdrawn on third day with perfect healing. This ureteral calculus was apparently a phosphate stone and weighed twenty-seven grains. A large calculus of the same character was removed from this patient's other kidney. It was broken and could not be weighed. It was phosphatic in composition, and measured over two inches in length. On the side where the ureteral calculus was found there was a large hydronephrosis, on the other a pyonephrosis. Other cases have been previously reported where encysted calculi were detected, and where multiple calculi were removed and the completeness of the operation assured.

"Such advantages clearly demonstrate the superiority of this method over exploratory nephrotomy or any other method of diagnosis. It is free from all danger and inconvenience, and is more accurate.

"The detection and accurate localization of the calculus, in cases of unilateral or complete anuria due to calculous disease, is of the utmost importance in directing and limiting the operative intervention. Complete anuria is readily recognized, but the localization of the seat of obstruction, although of the greatest moment, has hitherto been a most difficult problem, uncertain of a correct solution.

"The question of unilateral anuria can be settled by the segregator or the ureteral catheter, but calculous disease can only be detected or excluded with certainty by an X-ray negative properly made and interpreted.

"The patient should be given the benefit of such methods of examination before operative treatment is decided on. Without them he is exposed to the immediate danger of the loss of one kidney or to the future dangers that surround the presence of a quiescent calculus in the kidney. The advantages that are to be derived from early diagnosis and operation should never be forgotten. This early diagnosis can be made in all of these cases as soon as suspicion points to the possibility of a calculus.

"The formation of a renal calculus generally takes place without producing any recognizable symptoms. The condition is not sus-



pected until the calculus interferes with the function of the kidney or that of the ureter. This may take place while the calculus is small, or not until it has attained large proportions. The first symptom that usually attracts attention is pain. Either a dull, diffuse ache in the lumbar region, or it may be a severe attack of colic. This is sometimes accompanied by sufficient functional disturbance to produce a slight albuminuria, or a few leucocytes and red blood-cells may be found in the urine. If colic is present, and the symptoms are severer in character, interference with the function of the ureter is indicated. All these symptoms may, however, result from other causes, either intra- or peri-nephritic, and may even be more marked, and yet no calculus be present. The difficulties that lie in the way of an accurate differential diagnosis in the incipency of this condition are very manifest.

"A short time ago the diagnosis of renal calculus was never made until the classical symptoms showed that the pathological process had so far advanced as to render surgical intervention necessary, and yet hazardous. At that time the diagnosis of calculous ureteritis was never made, and many patients lost one kidney as the result of unilateral anuria, and many others died without any other diagnosis than 'suppression of urine' ever being made. The exact diagnosis of calculous ureteritis is seldom made even now. Many patients suffer the loss of function of one kidney because the impaction of a calculus is not recognized, and the resulting anuria leads to the atrophy and destruction of the affected kidney. The clinical pictures presented by destruction and recovery are identical. If a calculus passes after an attack of renal colic and escapes detection the pain subsides, the urine clears, and perfect function is restored. If a calculus becomes impacted in the ureter the symptoms do not differ apparently. If the urine becomes normal the 'cure' (?) is attributed to this or that internal medication, or the true condition is not suspected, or the attack is attributed to some other cause. The possibility of such an occurrence is readily admitted. The X-ray findings show that it is probably much more frequent than has been suspected. In a series of thirty-six cases detected by the author over fifty per cent. were ureteral calculi.

"Clinical experience shows that other pathologic conditions often simulate calculous nephritis so closely in their symptomatology that an absolute diagnosis cannot be made by ordinary methods. Even in exploratory nephrotomy an expert surgeon is liable to err. This was shown in the case of Taylor and Tripp, and has lately been demonstrated in another case in which a large calculus was not detected by an expert surgeon, who even went so far as to report it as a case 'in which the symptoms were most misleading, as they were typical of calculus, yet none was present.' The radiograph demonstrated the presence of the calculus.

"The mechanical accuracy of this method is very great. Error can creep in only through faulty technic or lack of skill in reading

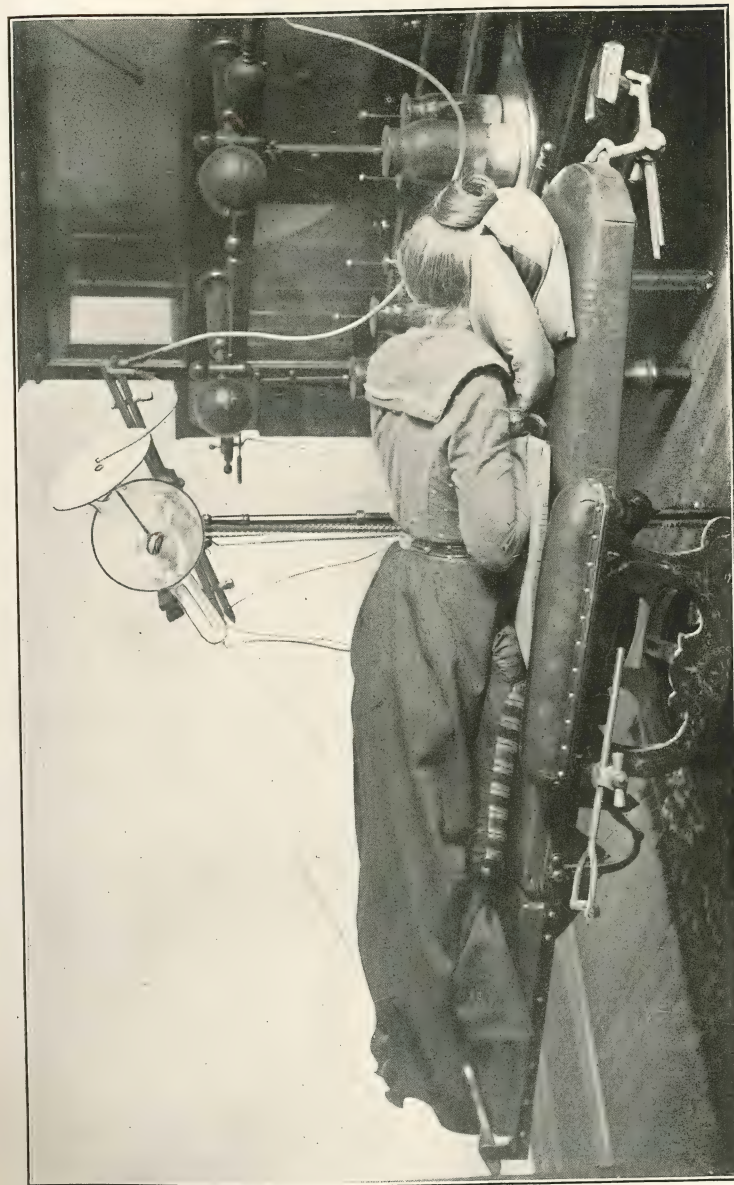


PLATE 117.—Method for Gall-stone Radiography. This Instruction Plate is remarkable from the fact that it illustrates a successful case during the actual making of the radiograph. Mrs. A. M., age thirty-four, history of acute attacks of cholecystitis. There was marked jaundice, temperature 100° F., pulse 120. Patient weighed 101 pounds, was five feet three inches in height and very thin. Cut shows apparatus and posture for fifth exposure, tube axis passing through gall-bladder at an angle of 60 degrees to avoid liver. Exposure 50 seconds. Two gall-stones found and removed a week later. One was round and contained phosphates only. The other was elliptical with a nucleus of cholesterine with phosphates around. Photographed especially for this Instruction Course by Dr. Jicinsky, whose case it was.





PLATE 118.—Radiograph of Calculus in gall-bladder, verified by operation and removal of stone. Arrow points to the calculus. Despite loss of detail in reduced half-tone the stone shows clearly.

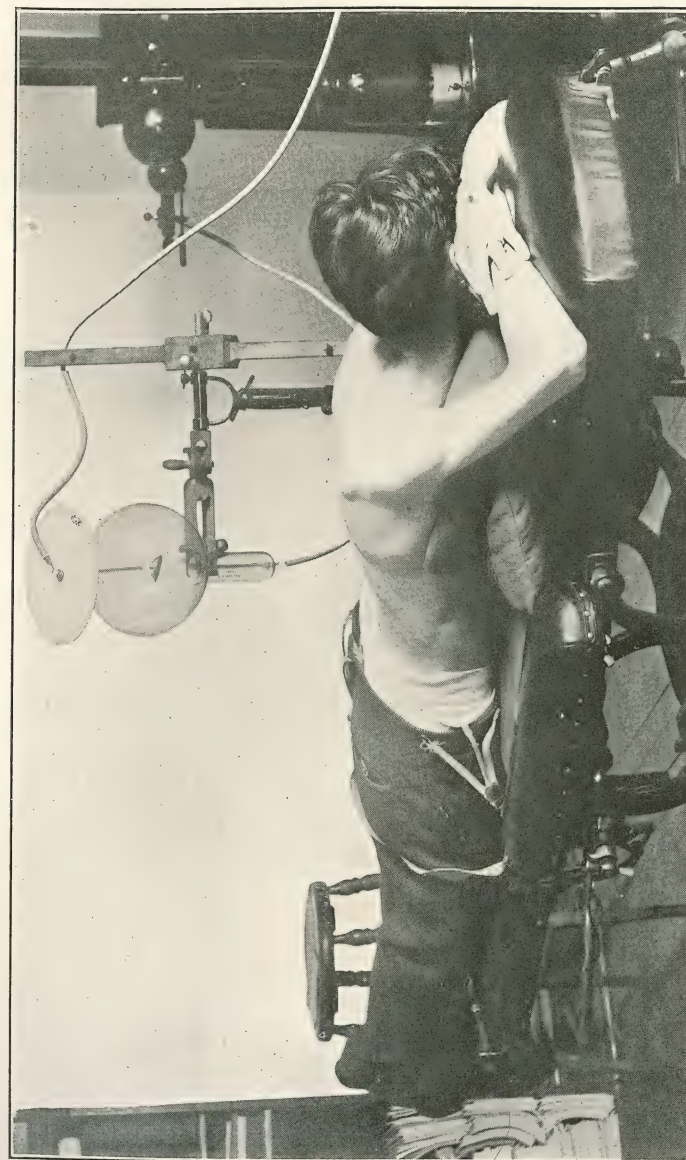


PLATE 119.—Method for Renal Calculus. Case of Dr. Jicinsky. The exposure was five minutes. Large calculus in left kidney found on the negative. Diagnosis verified by operation. The radiograph resulting from this exposure is not reproduced, as half-tones lose so much of the detail of originals. The technic shows so plainly in this Instruction Plate that any surgeon can follow it.



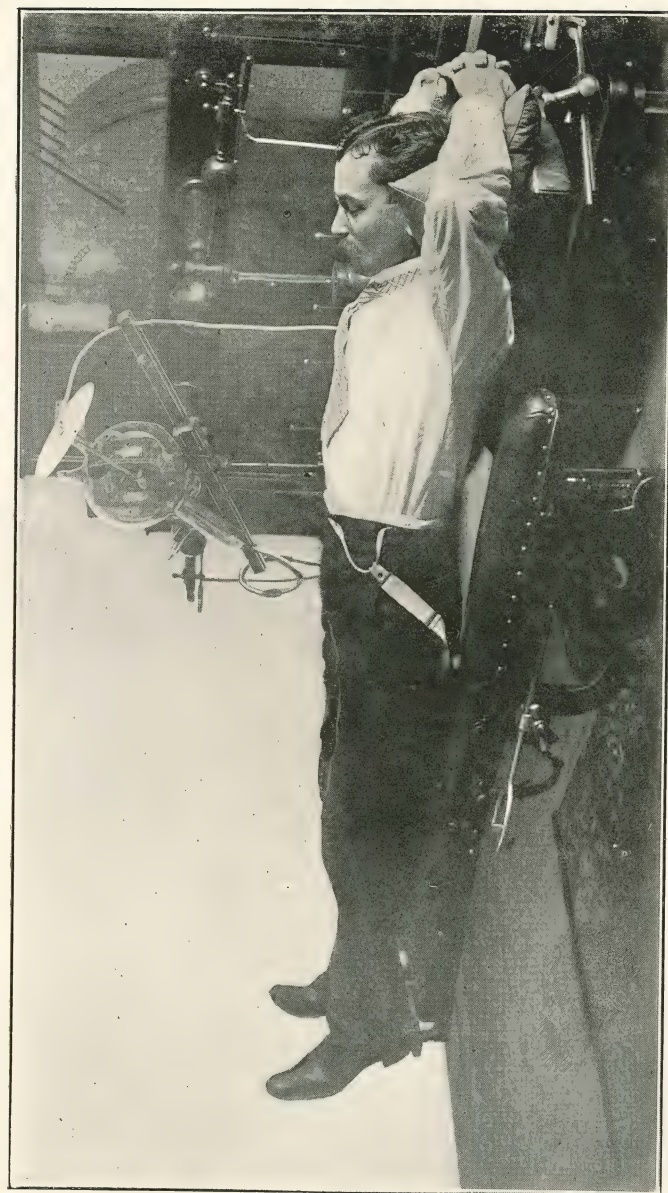


PLATE 120.—Method for Renal Calculus with dorsal position of patient. Photographed especially for this Instruction Course by Dr. Jicinsky during the actual exposure of a radiograph which resulted in detecting the calculus. The method is shown so plainly that others can easily duplicate it.

the negative. Where the negative secured fulfils the requisite conditions the experienced eye can detect or exclude all calculi. In some cases, as in very corpulent or muscular subjects, it is not yet always possible to secure a negative with the essential detail, but when the negative is correct the diagnosis is *absolute*. Exhaustive studies by Swain, Ringel, Wagner, Buget, Gascard, and others have shown that renal calculi have varying degrees of opacity to the X-rays corresponding with their chemical composition. Oxalates are the most opaque, phosphates next, carbonates the same, and uric-acid calculi least. Size is more important than composition, and even the least dense uric-acid kind have been well shadowed on the plate. The cases in which the author has so far demonstrated the absolute mathematical accuracy of the method number 165.

"The method is based on the axiom that if rays are employed that will differentiate between the shadows of tissues less dense than the least dense calculus all calculi will be found. The absolute proof of the diagnosis is evident in each negative *when such a differentiation is shown*. If the calculus is there it will be seen, and if none appears on such a negative it does not exist. The production of negatives having these details in the soft tissues of the lumbar and pelvic regions is the only essential to the diagnosis, and is secured by the employment of a large *volume* of radiance having a medium penetration. Experience has shown that the vacuum requisite is equal to one to two inches of air-gap resistance as measured by a coil.\* This latitude in resistance is necessary in regulating the penetrating power of the rays to the individual patient. For the same reason the length of exposure varies with the individual, and is also dependent on the amount of energy in the secondary coil circuit. A *heavy current without thin voltage* is the chief factor in producing a large volume of radiance such as is required.

"The only basis on which a diagnosis can be reasonably established is the production of a negative which, in the individual case, visibly differentiates between the shadows of tissues less dense than the least dense calculus. The effect of different doses of radiance on penetration is shown in two pictures. The calculi were laid on the film. The tube was the same in each exposure. The same exposure-time was used. The plates were developed in the same bath for the same time. The only factor that varied was the resistance of the tube, which in one case was a three-inch spark-gap and in the other less than one and one-half inches. The *negative* and *positive* diagnosis are rendered absolute by the present technic, but the operator must be able to show in his negatives the definition of lumbar and pelvic soft parts less dense than any calculi. *One* such negative showing such detail in the regions occupied by the kidneys and ureters is sufficient evidence upon which

\* The student will note how much more difficult it is to get an accurate idea of the X-ray dosage employed by the above writer than it would be if the author's gauge tested it. It could then have been stated at once whether the radiance should be  $X_4$ , or  $X_8$ , or  $X_{10}$ , or any other power.—Ed.



to base a *negative diagnosis*. A *positive diagnosis* should always be confirmed by a *duplicate* picture taken on the same day. As in all cases of localization of foreign bodies, operation should follow as soon as possible.

"Bigelow's evacuator is very serviceable in finding small calculi that have passed into the bladder, but no further. An examination with it should always precede operation for the removal of a small ureteral calculus that has been detected by X-rays, especially if an interval elapses between its detection and the operation, or if attempts have been made by massage to dislodge it. This is equally true of all foreign bodies. Operation must follow immediately after the localization or the localization must be repeated. Immobilization is always essential during the interval.

"The rendering of correct diagnoses in cases where the symptoms are indefinite or wanting illustrates the great value of the method. The *positive diagnosis* has, however, a greater value than the simple detection of a calculus. It is more accurate, comprehensive, and precise than any other method. The position of a calculus or calculi in both kidneys and ureters is determined with a precision that limits the field of operation, makes the operation more accurate, and assures its *completeness*. It is no longer necessary to open a hydronephrotic kidney before the ureteral calculus, which is the real cause, can be located. The operation is directed immediately to the ureter. In two cases remaining calculi have been found in the opposite kidney after operation, and in another case a calculus was found in the same kidney previously operated on. Such incomplete work cannot be done after a thorough X-ray diagnosis. Calculi have been present in both kidneys or ureters in four cases examined. This is the only method except double exploratory nephrotomy by which it is possible to exclude calculus from the apparently healthy kidney before a nephrolithotomy or a nephrectomy is undertaken.

"The detection of three calculi weighing one grain or less in the kidney and ureters and their subsequent passage has demonstrated that this method is capable of detecting the most minute calculus in its incipient stage. This is of the utmost value to the patient. These are the calculi that produce complete anuria by occluding the ureters. They are the more dangerous because they produce fewer and less definite symptoms. Morris has said of them: 'If such silent, lurking calculi could be discovered and removed, many deaths from calculous anuria, much illness and suffering from perinephric abscesses and renal fistulæ, and many kidneys undergoing atrophy and degeneration might be saved by well-timed operation.' Statistics derived from the operations of the most competent renal surgeons show that the mortality of nephrolithotomy is but two or three per cent., if the operation is undertaken when the calculus is small and before infection has taken place. When the characteristic symptoms are present and infection has taken place, the mortality rapidly rises to twenty-five per cent. This method assures the detection of all calculi as soon

as a suspicion points to their presence, and by their early diagnosis affords the patient all the advantages of an early operation. *The examination is made with no inconvenience to the patient and without the introduction of instruments into the bladder or ureters, and the consequent danger of infection.*

"The value of the absolute *negative diagnosis* by this method is possibly *greater than that of the positive*. It often renders operative intervention unnecessary, and at the same time renders medical treatment rational and not dangerous. The accuracy of the negative diagnosis by skiagraphy has been seriously and frequently questioned. Since claiming that the *negative diagnosis* is accurate, the author has examined 136 cases suspected of having renal or ureteral calculi. A negative diagnosis has been rendered in 100 of these cases. In only one case has that diagnosis been disproved by the operation. In that case the error resulted from a misplaced plate and defective reading of the negative.

"Sources of error lie not in the method, but in its improper employment and interpretation. Experience in developing and employing the various qualities of X-rays must be combined with clinical experience in reading negatives and translating them into diagnosis. This is often the most difficult part of the task, especially when the diagnosis is negative instead of positive. When, however, the correct reading has been determined the plates form a mechanically produced proof that is capable of demonstration. A *negative diagnosis* by this method is the one means by which the *non-operative treatment of suspicious cases can be made rational*. The dangers surrounding the treatment of cases that simulate renal or ureteral calculus, by non-operative methods, are clearly evident from the consideration of the similarity in symptomatology between recovery and the destruction of a kidney by calculous anuria.

"The passage spontaneously of a number of the ureteral and of one renal calculus, after they had been detected, points toward conservatism in operating in certain cases. Such a course is safe and rational where it is based upon the data obtained by this method. The exact determination of the size and position of a calculus makes it possible to estimate the chances of its passage. It makes it safe to wait, as the seat of any operation that may be necessary is predetermined. The presence of infection, the size and position of the calculus, and the previous history will have much weight in these cases. The persistence of pain in the lumbar region and the history of repeated attacks, with the presence of blood in the urine, point to partial occlusion and make delay permissible. A large calculus, the presence of infection, or an absolutely normal urine, indicating unilateral anuria, make immediate operative intervention imperative if the kidney is to be preserved. Such conservative treatment must, however, be conducted under strict surgical supervision, and frequent analyses of the urine should be made. The ease with which such minute calculi slip into the bladder renders it necessary to search for them in the bladder



before any operation is commenced for their removal. This precaution should always be observed with small calculi, and the bladder carefully examined by a Bigelow's evacuator while the patient is under the anæsthetic before the operation is commenced.

"The effect of this method of diagnosis upon operative procedures has been marked. The field of operation has been *localized* by X-rays to the point where the calculus is situated. The completeness of the operation is assured by the determination of the exact number and position of the calculi. The calculus can be removed through a much smaller wound in the kidney, with the assurance that no calculi are left behind. Ureteral calculi are attacked directly either by the extra-peritoneal route, by trans-peritoneal ureterolithotomy, and by puncture of the ureter through the vaginal vault. All these methods have been successfully employed in one or more of the cases examined. With the exact knowledge of the location of a calculus, it will often be possible to palpate it, and in especially favorable instances to push it along by massage, or even by crushing small calculi of suitable composition, to secure their removal. From the examination of 136 cases suspected of having renal or ureteral calculi, and the detection of nineteen cases of ureteral and seventeen cases of renal calculus, the author draws these conclusions:

"That both the *negative* and *positive* diagnosis by the X-ray method are accurate and valuable. That ureteral calculus is much more common than has been supposed, or about fifty per cent. of all cases of calculus. That it is impossible to arrive at as accurate a diagnosis of calculus by other methods. That this method is comprehensive, and aids operative intervention by localizing all calculi and excluding calculi from the other kidney. That non-operative treatment, without a negative diagnosis by this method, is irrational and dangerous in cases that are at all suspicious. That this method is precise, because its results are mechanically produced, but that accuracy in its employment and care in reading the results are necessary to the avoidance of error. That the data obtained by this method make non-operative, conservative treatment rational in cases of small calculi low down in the ureter that can be expected to pass. That the negative diagnosis does not preclude exploratory nephrotomy, but does make unnecessary the actual incision into the kidney in search for calculi. The dilatation of the ureter with bougies, as has been practised in the female, may be employed in the male by utilizing a suprapubic cystotomy wound to guide the instruments from the urethra into the ureters." (LEONARD.)

From facts in possession of the author it may be estimated that at this date not less than 200 different operators have successfully radiographed calculi of the various forms. This is a great advance on the situation of two years ago, and we may assume that much further progress will be made. Within a few months Drs. Schmidt and Kolisher have reported a special technic which involves the introduc-

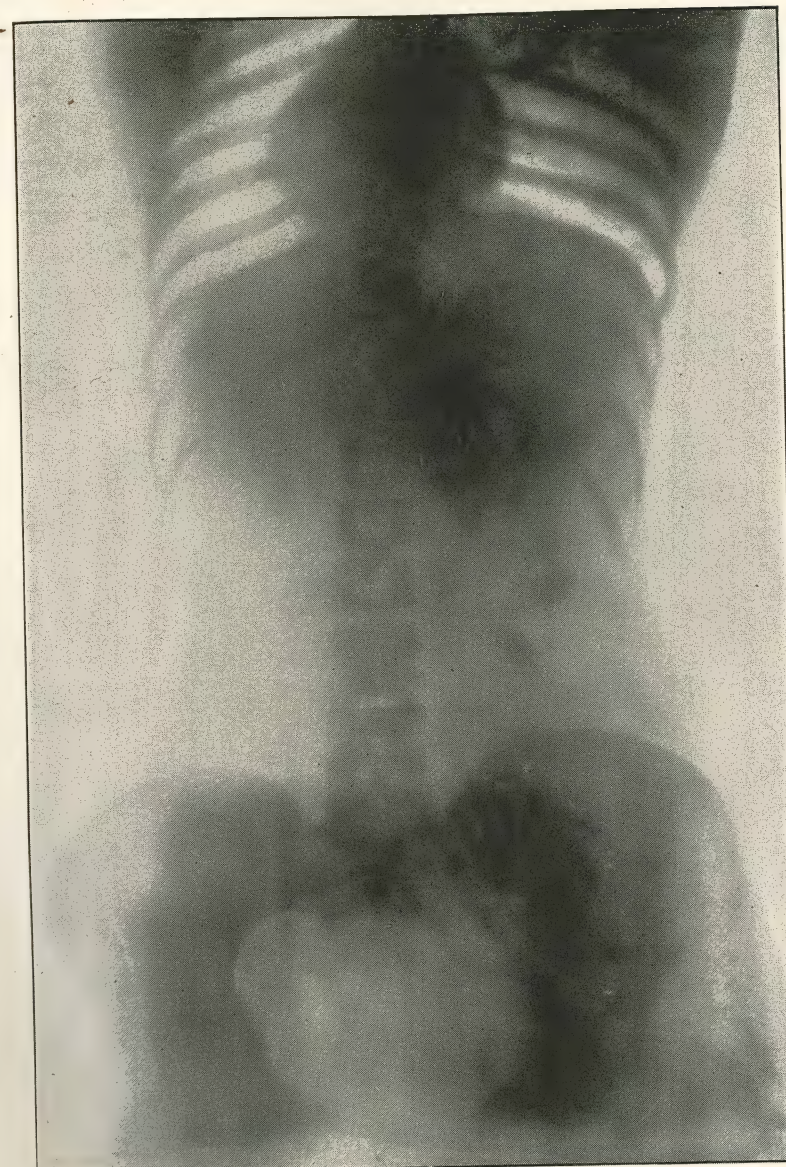


PLATE 121.—Renal Calculus (Walsham). Case of woman age thirty-nine. The diagnosis lay between renal calculus and tuberculous kidney. The X-rays cleared up the doubt. The negative showed that at least three stones were in the kidney, and the operation revealed a large number, varying in size from a large bean to a pin-head. They were composed partly of calcium oxalate and partly of phosphates. Good recovery. Both these radiographs of renal calculi were made with a twelve-inch coil and medium tube, with four minutes exposure. No special precautions with regard to holding the breath were taken in either case. The radiographs of the calculi after removal were made with the same coil and a few seconds exposure. (Rebman, Ltd.)





PLATE 122.—Life-size radiograph of the preceding renal calculus after removal from the patient. (Rebman, Ltd.)



PLATE 123.—Renal Calculus (Walsham). Case of a woman age thirty-three. Weight of stone on removal was  $1\frac{1}{2}$  ounces, composed partly of calcium oxalate, partly phosphatic, the latter predominating. Recovery. The effect of reducing the radiograph to book size is well shown by the next picture of the calculus after removal. The shadow presents the appearance of two stones, but it proved to be a single calculus filling nearly the whole pelvis of the right kidney. (Rebman, Ltd.)





PLATE 124.—Life-size radiograph of the preceding renal calculus after removal from the body. (Rebman, Ltd.)

tion of soft and flexible metallic sounds into the ureters and kidneys for the purpose of securing accessory shadows as aids to diagnosis. On October 24, 1901, Dr. Schmidt wrote the author that since his paper before the American Medical Association they had had additional cases in which the method had been of great service. The lines of the metallic sounds stand out beautifully in the negatives, and show the course and situation of the ureters and the contour and size of the pelvis of the kidney.

"We use for sounds for this purpose lead-wire of different sizes and flexibility. We melt one end into a small ball. Lead-wire has sufficient tensile strength to stand manipulation without breaking, and, on the other hand, is so soft and pliable that injury to the tissues of the ureters and kidney is impossible even when there is dislocation of the ureter and a maximum of pressure is used. We use a cystoscope patterned after the instrument of Brenner and Casper. The diagnostic possibilities of this method are the following:

- "1. The absolutely exact position of the course of the ureters.
  - "2. The exact localization of any obstruction in the ureter.
  - "3. The exact topographical localization of the pelvis of the kidney.
  - "4. The solution of a difficult differential diagnosis between biliary and renal calculi.
  - "5. Knowledge of the size of the pelvis of the kidney.
  - "6. The nature and meaning of any obstruction in the ureter.
- "That these differential diagnostic possibilities are important and the command of them often welcome needs no emphasis. It is clear that the precise location of, for instance, an obstruction (an impacted calculus) in a ureter is of the greatest importance, for upon this point depends the accuracy and direction of the incision. The difficulties surrounding a differential diagnosis when a greatly distended gall-bladder, a floating kidney, or even a dilated kidney is encountered are well known. The uncertainty is lessened if in a case of this kind a metallic sound strikes directly upon a renal or ureteral calculus and is radiographed *in situ*. Furthermore, the pliable lead-wire pushed to the limit of obstruction without danger will then roll up and outline the contour and shadow the size of the pelvis of the kidney in a renal case."

An experiment was first made on a cadaver. The lead sound was introduced with strong pressure and pushed forward as far as possible. Owing to the resistance of dead tissues it bent in every direction, finally doubling on itself and forming a loop in the pelvis of the kidney. After experimental radiographs an autopsy showed that no injury of any kind had been done to the tissues by pressure on the soft lead. Three radiographs showing sounds *in situ* in bladder, ureter, and kidney were presented.



The following on renal calculus contains useful information:

"The radiograph exhibited shows a calculus in the right kidney, three-fourths of an inch in diameter, in a female child aged three and one-half years. The apparatus used was three twelve-inch spark induction coils connected in series and capable of giving a thirty-inch discharge of large volume, the secondaries being wound with No. 32 wire. The 110-volt direct current was used, regulated by a rheostat to the capacity of the tube. About eighteen amperes was let into the primary coil circuit. The tube was a General Electric funnel-focus tube with vacuum regulator, and the resistance backed up a parallel spark two inches long. The series spark-gap was one and one-half inches. More current was used than the tube would take continuously without melting the anode, and when it became too hot the current was cut off for a few seconds by means of an adjustable shunt spark-gap which regulated the current through the tube.

"The patient was anesthetized and placed on her back with the tube *over the median line, level with the iliac crests*. The child would not keep still without the anesthetic. A double-coated X-ray plate was used and developed with the metol-hydrochinon formula. Time of exposure was seven minutes, with the tube twenty inches from the plate. Thickness of the body on a line with the calculus was five and one-half inches. A second case was an adult, male, aged thirty-six. Calculus in right kidney. Postured on back; tube over kidney; distance, twenty-six inches; exposure, eleven minutes; body, twelve and one-fourth inches thick. Used double-coated X-ray plate.

"From reports of cases the general idea of locating a calculus seems to be to use a tube of as great penetrating power as possible, make a short exposure, varying from one to four minutes, and obtain a really under-exposed negative. It is assumed that a longer exposure will penetrate the calculus to an extent that will reduce its outline on the plate or obliterate it. I have tried all lengths of exposure, from a few seconds up to twenty minutes, and my most uniform results have been secured as follows:

"Use a tube which will take a large current and give off a large quantity of X-rays. Adjust it to just enough penetration to produce a normal plate for the given thickness (adult) in from ten to thirteen minutes, according to the thickness. In developing the plate aim at securing as much detail as possible." (Scott.)

**Biliary Calculi.**—In the living subject with early vacuum tubes and technics only such calculi could be radiographed as consisted of a firm and hard layer like the oxalates, while the more permeable urates cast an indistinct shadow, and the transparent phosphates scarcely appeared at all. The chemic composition of biliary calculi is far more complex than that of calculi in the urinary tract. All the different types have been experimentally radiographed on a plate outside the body, and also through the body of a patient to ascertain their differ-

ence in translucency, but the difficulty of shadowing them on a plate in living *situ* is not solely that of deficient density but of obscuration by respiratory movements. When technic controlled these movements success followed.

The common biliary calculi of the most frequent type is so permeable as to cast only a slight shade when small and single, but when larger and multiple the shadow is proportionately more dense. The mixed bilirubin calculi which contain traces of iron and copper, and pure bilirubin-calcium calculi, are found to be the most opaque, and hence yield the most distinct shadow in the radiograph. Pure cholesterolin and stratified cholesterolin calculi are slightly more opaque than the common biliary type. When gall-stones are discovered too large to pass the common duct medical treatment can presumably be only palliative, and operative interference may be deemed indicated. When medical treatment is tentatively undertaken in such a case a subsequent radiograph may detect whether or not calculi have passed on into the duodenum. In regard to technics Beck has the following:

"A fine tube is a *sine qua non*. The more translucent the calculus the shorter must be the exposure. Pure cholesterolin needs a shorter exposure than a calculus containing lime, but the trouble is that we do not know the chemic composition of the suspected stones in advance. We therefore do not know what length of exposure-time will be necessary, but we can partly overcome this difficulty by making a minimum and a maximum exposure at the same time. If the short exposure reveals a calculus while the long exposure is negative, then the probability is that a cholesterolin formation is present. Even a poor negative, if it shows but the faint outlines of elliptic and faceted bodies in the region of the gall-bladder, is positive evidence. Sometimes the film shows nothing but the calculi. The plate must always be carefully studied, because the inexperienced eye will often not recognize calculi which are obvious to the trained eye at a glance.

"In skiagraphing a gall-bladder have the patient lie on his abdomen with three pillows under the clavicles, for this elevation permits the protrusion of the gall-bladder and brings the calculi nearer to the film—an important feature. Also place a thick pillow under the symphysis pubes to arch the body. The nearness of the gall-bladder to the plate is also increased by turning the body slightly to the right and raising the left side.

"Another point of importance is that the axis of the rays should not be directly vertical over the gall-bladder, but should penetrate from the side, to avoid the thick and denser mass of the liver through its full diameter. Make the rays bear an angle of about seventy degrees with the plate, and the tube should be as near the abdomen as possible. When a protrusion, palpable in the region of the gall-bladder, indicates that it projects from the liver, direct vertical position of the



rays is to be preferred. In the case of oblique exposure the slant of the rays will make the calculi appear larger than their actual size."

In his first success Beck used four superimposed plates at the same time. The top plate directly under the gall-bladder showed the outlines of the liver well, while in the last plate it appeared but faintly, but on this plate the calculi were clearly represented. The next exposure was made with a high tube on a single plate; time, ten minutes. After it was found how long it took this tube to show the liver and pelvic bones a second plate was exposed for six minutes. This negative showed the denser tissues less clearly, but the calculi were more distinct. An exposure of seven, one of eight, and one of nine minutes, were experimentally made, all showing that the *longer* the exposure the clearer were the denser tissue and the *fainter* were the calculi. It thus became evident that one exposure was not sufficient to determine the length of time required by a given tube for each gall-stone type. Tests should therefore be made by first making a trial short and a trial long exposure in a case of suspected cholelithiasis, say, one of four minutes and one of ten. By comparing the results of these test-exposures the proper time for a final exposure can be estimated.

"By employing this method not only the size, shape, and diameter of the gall-stones may be determined, but they can also be localized. It can also be shown whether there are calculi in the liver or the common duct besides those shown in the gall-bladder. Formerly it was only after extensive exposure by laparotomy that such diagnosis could be made with any degree of certainty. Exploratory laparotomy for suspected cholelithiasis will hardly be deemed necessary any more. The statement that the chemical composition of the calculi will have much to do with successful definition on the plate has been found to be correct to some extent only. Common calculi of the most penetrable type no larger than the head of a pin have been detected. Even calculi in the hepatic ducts have been shown. The bowels should be thoroughly evacuated before attempting the radiograph."

Moulin, in the London *Lancet*, early in 1899, wrote as follows of radiography of renal and biliary calculi:

"As regards renal calculi, the condition of the patient and the composition of the stone both affect the result. If the patient is thin, and the calculus of oxalate of lime, positive results can usually be obtained. Phosphatic calculi are harder to detect, and those of uric acid or urates still more so. If the patient is corpulent and muscular, success is less certain. *In difficult cases such as these, every endeavor must be made to reduce the thickness of the tissues by purgatives and enemata.* The position of the patient is important. The erect position fixes the object better, but crowds the liver down in front and increases the antero-



PLATE 125.—Radiograph of Renal Calculi. The arrows point to the shadows of two phosphatic stones which were removed by operation and the negatives confirmed. These soft calculi are here clearly shown, although prior to 1901 many claimed that they could not be defined by the rays.



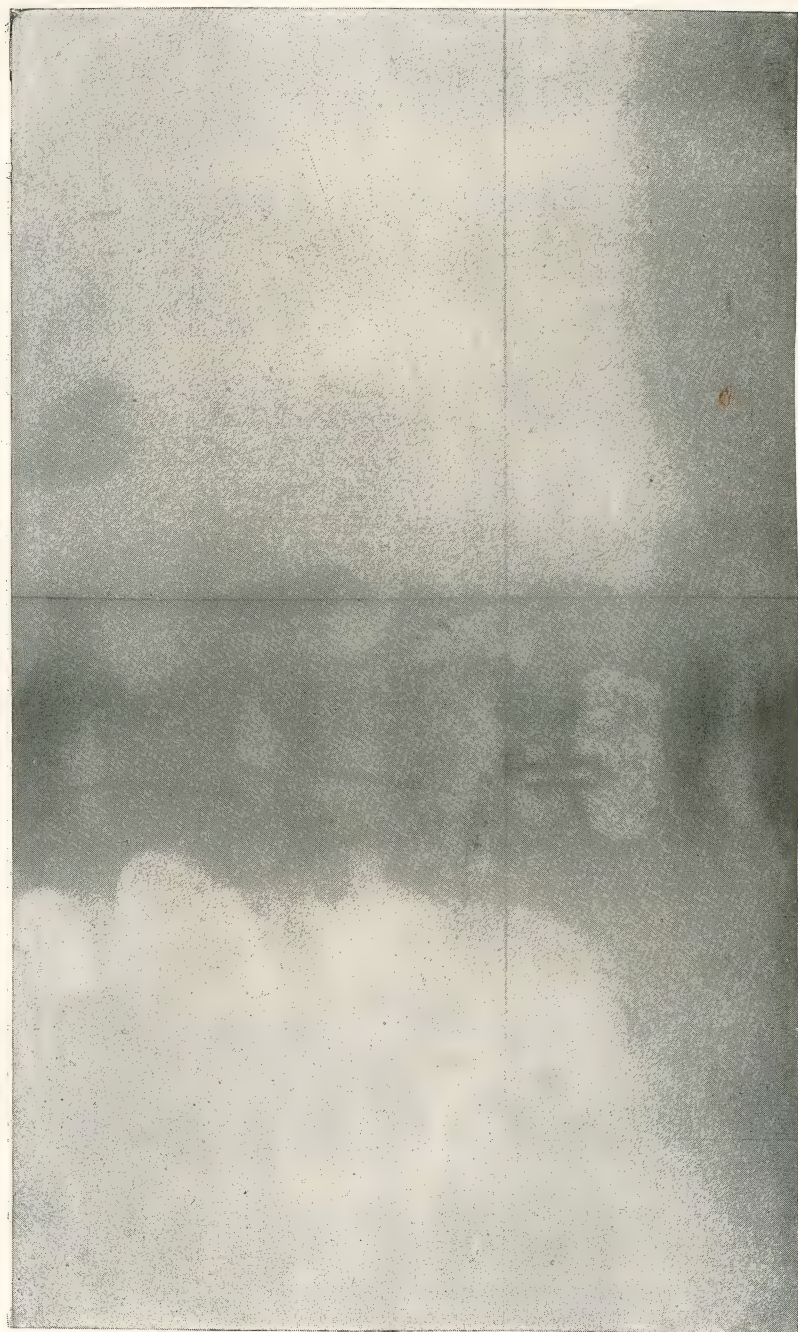


PLATE 126.—A stone in the right kidney. Done by Davidson with patient on back. Anode 13 inches from plate. Exposure 2 minutes. Ten-inch coil and mechanical interrupter. In the last of three cases examined soon after by the same operator and using a Wehnelt interrupter the renal calculus could "be distinctly seen on the screen." It was also radiographed. Note the division of the negative into quadrants by the cross-wires by method illustrated in a previous chapter.

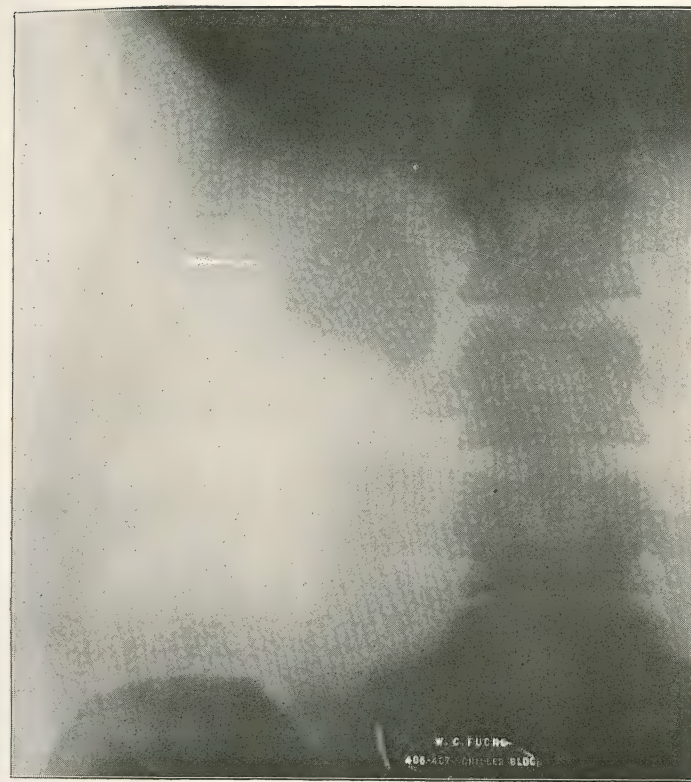


PLATE 127.—Arrow points to large stone in left kidney which was removed by operation, verifying the radiograph.



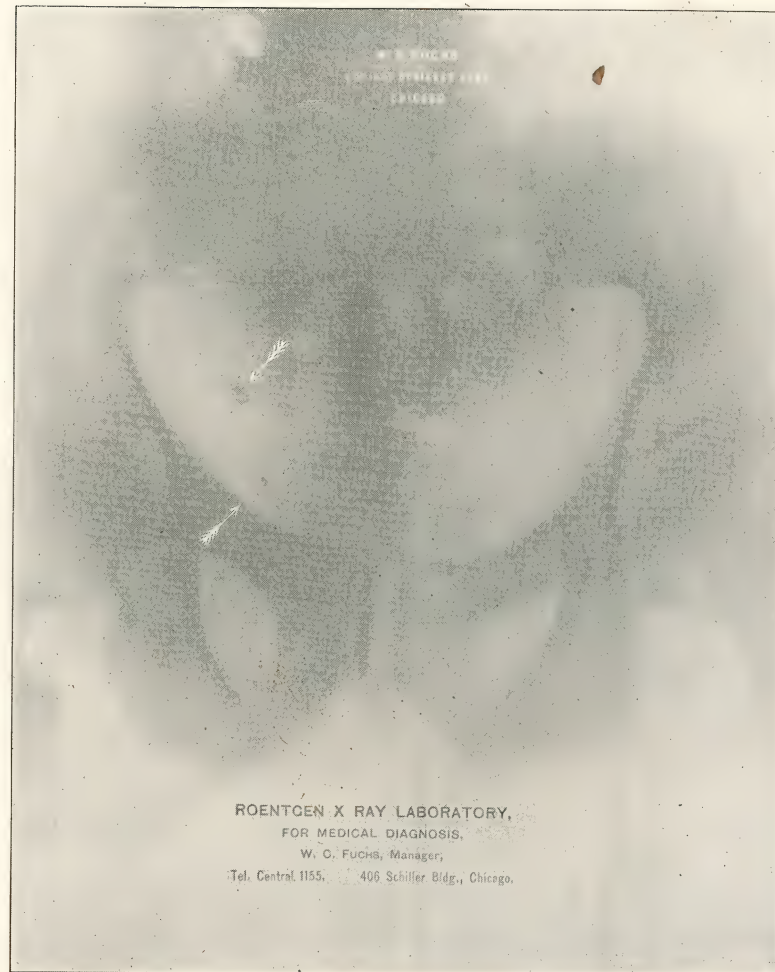


PLATE 128.—Ureteral Calculi. First radiographed with tube placed for suspected stone in kidney with no result. Tube was then focussed on course of ureter, and the two calculi here shown were discovered. Removed by operation, which verified the findings of this negative. The arrows point to the two shadows.

posterior diameter of the body. *Have the patient recumbent with the back well arched.* Make examinations both from the front and from behind, as it cannot be told in advance which will yield the best results with some patients. To prevent movement of the calculus from respiration, direct the patient to hold his breath as long as possible in forced expiration, to raise the liver. Then cut out the tube and allow him to breathe until he has recovered himself, and resume the exposure for a second period of arrested respiration, with the thorax the same as before. Repeat this as often as necessary till the radiograph is completed. The tube is only switched on during the period of apnoea when the thorax is at rest, and the kidneys and the calculi are presumably occupying the same position relatively to the light. As regards biliary calculi, they are still more difficult, owing to their very low densities. The difficulty is greatest when information is most wanted, that is, when the calculus is not in the gall-bladder but in the ducts, and when the patient is stout and the abdomen firm."

**Technic for Renal Calculi.**—Previous to the exposure fast the patient and thoroughly empty the bowels. Remove all clothing from the region to be radiographed. Have the patient make forced expiration and tightly secure a thin muslin binder around the abdomen to restrict movement of viscera during respiration. This is important. Place the author's Position-Finder on the table and centre a high-efficiency tube at twenty inches for an 11 × 14 plate. Remove the rod and all is ready for posing the patient. There are now three objectives which govern the placing of patient and tube. The purpose of the picture decides the technic, and an advance choice must be made.

1. Exposure of both kidneys at once for suspected presence of calculi.—Bring in the plate and place it on the centred base under the tube. Lay the patient on the plate so that the third lumbar vertebra is on the centre of the film. Prop the patient with suitable towels so as to secure comfort and to make the closest possible contact of the part with the film. The focus of the anode being over the centre of the spine the diverging rays will carry the shadows of the kidneys well out from the bones on each side, and equally image both sides with neither in the perpendicular axis. This is immaterial in simple detection.

2. Exposure of one kidney only.—Mark the region of the selected kidney on the skin, and then simply lay the patient on the plate with the marked area over the centre of the film. The kidney will then be in the vertical axis of the rays, and there will be no divergence to consider. The shadow of the single kidney will fall directly below it to the plate. The patient may be placed either on the back or abdomen, and it is often best to make an exposure in each position to ascertain which gives the best result in the given case. A thin person will suit



the frontal posture best. An obese person will suit the dorsal decubitus best, as a rule. Use the Distortion Landmark as a guide to approximate localization.

3. To localize a calculus after preliminary detection.—Having found the shadow of a calculus in the image of one side of the body and desiring to exactly localize it in the kidney or ureter, mark on the skin its estimated situation as indicated by the first radiograph. Place the patient so that this mark is on the centre of the film and the focus of the tube vertically over it. Select and employ the preferred method of ascertaining the seat of the calculus from our chapter on Localization.

When all is ready for any one of the above exposures have the patient keep absolutely still and breathe as little as possible while the current is switched into circuit. With the fluoroscope observe the action of the tube and time the exposure as taught.

A fine photographic screen of tungstate of calcium may be applied to the film of the negative to shorten the exposure. Or, the plate may be sandwiched between two such screens, as is done by leading operators in Europe to some extent. A diaphragm may be used to cut out all but the direct rays.

*Results.*—The shadows of the last rib and the transverse process of the first lumbar vertebra are guides to look for the calculi in the developed negative. Develop slowly with weak solution, watching these shadows and avoid fading them by too rapid or over-development. It is almost true to say that here (aiming at retaining on the plate shadows of tissues less opaque than the least opaque calculi) *development* is more vital than exact exposure-time. With experience the art grows.

If nothing is seen on the plate at the end of development that may be considered evidence of a calculus *intensify* the negative and let it dry. Then place it in the examining-cradle, as elsewhere described, and with the borders dark and with regulated transmitted light, study the shadows at various distances up to six feet. If this discloses any specks which may be suspicious repeat the exposure with such modifications as appear indicated by the result of the first attempt. When the shadow of the calculus is seen on the plate the diagnosis is positive. When several plates give clear definition of the field without suspicion of stone, and especially if outline of the kidney is secured, the diagnosis is negative.

*Remarks.*—It has been surmised that many of the failures of the past to radiograph renal calculi when they were actually present were due to making more or less long exposures with the patient permitted

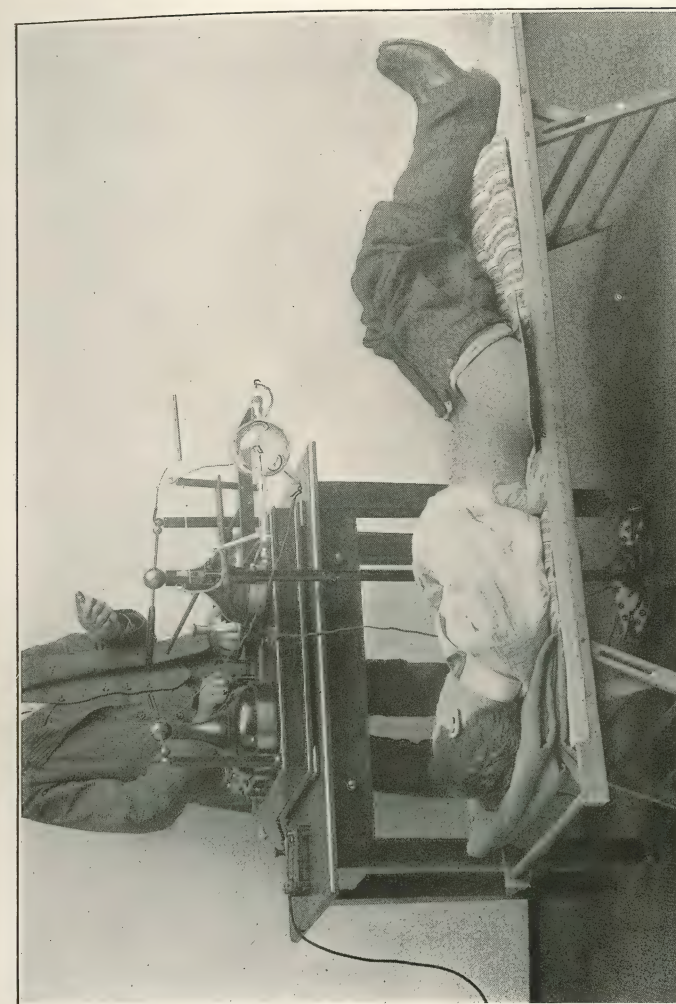


PLATE 129.—Radiographic exposure for Vesical Calculus. Patient on canvas stretcher with region exposed free from clothing.





PLATE 130.—Radiograph of Vesical Calculi showing two stones in the bladder, both of which were removed by operation which verified the negative. The arrows point to the calculi.



PLATE 131.—Stone in the Bladder. The electrotpe shows scarcely any of the fine detail of the original negative.

It is, however, inserted here to point out that no practitioner should form his opinion of radiography from the ordinary blotches of well-nigh meaningless ink that figure as copies of superb negatives in the hasty presswork and coarse paper of ordinary medical journals. They bear little relation to real radiography.



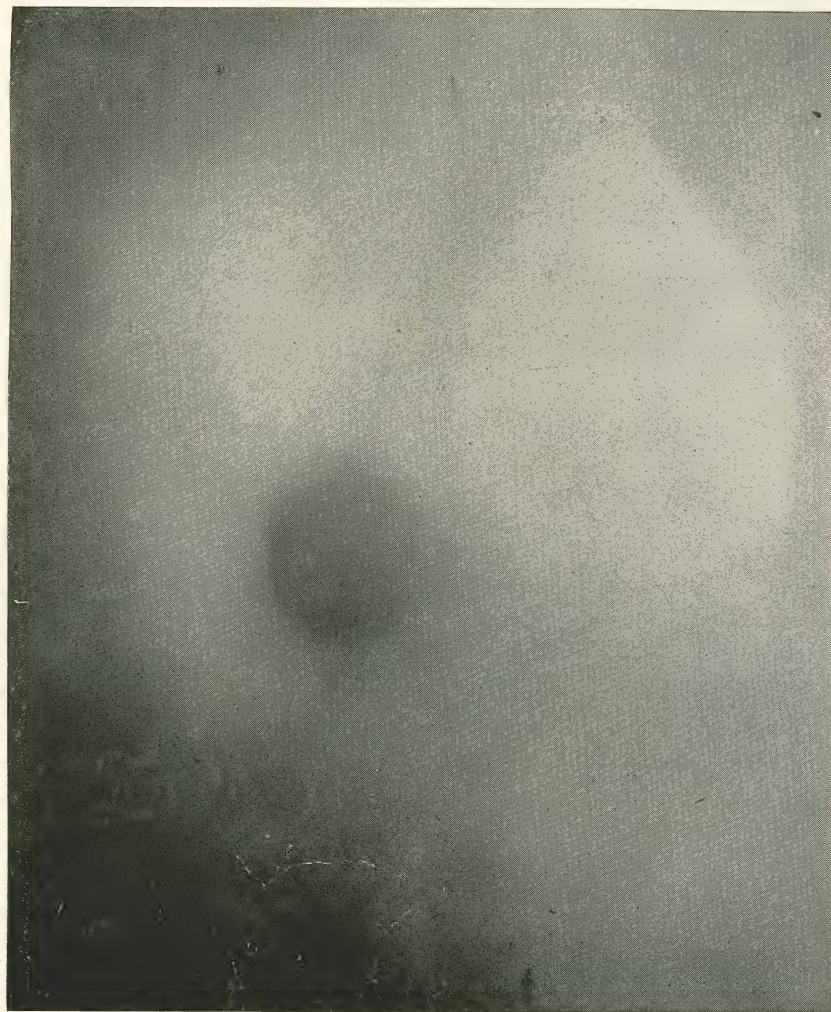


PLATE 132.—Vesical Calculus by Mackenzie Davidson. This radiograph was made prior to July, 1897, and the technic was as follows: The patient was placed face downward on a rapid film wrapped in two folds of black sateen cloth under the pelvis. The posture was such that the stone would fall to the front wall of the bladder and thus come nearest the film. The tube was so placed that the rays should pass obliquely through the pelvis and avoid the intervention of the bones. The result shows the shadow of the calculus, which was estimated by the operator to measure 3.4 centimetres diameter. The actual measure was 3.1. The exact distance of tube and time of exposure are not stated. The loss of fine detail in the half-tone greatly lessens the value of the illustration. (Rebman, Ltd.)

to maintain ordinary respiration. The repeated movements of the ribs, the soft parts in general, and, possibly, to some extent of the kidneys themselves, would blur out the faint opacity of a small sub-stance of slight density hidden deeply from the plate and hard to outline. The more nearly fixed the stone during exposure the less difficult to image its margins. In addition to the binder the patient can aid fixation by letting out his breath and holding his muscles still as long as possible. Stop the tube when he must relieve the lungs, and work it *only while the parts are under forced expiration*. The shortest practicable exposure-times are best for clear definition.

**Technic for Vesical Calculus.**—In exposing a patient for a radiograph in a case of known or suspected stone in the bladder not only should the intestinal tract be flushed out, but at the last moment the bladder itself should be evacuated, as water casts a shadow with X-rays.

**Abdominal Position.**—Place the patient face downward with the vesical region on the photographic plate, tilt the table so that the stone if present will gravitate to the front wall of the bladder nearest the film, place the tube so that the axis of the rays will pass obliquely through the soft parts of the pelvis and avoid the heavy bones. Make a short exposure with the tube-wall about eight inches from the tissues. Always remove clothing from the pelvic parts.

**Dorsal Position.**—Place the patient on the plate so that with pillows under the back and the knees drawn up the outlet of the pelvis will be in the nearest relation to the film. Place the tube over the abdomen above the umbilicus so that the axis of the rays will fall through the pelvis perpendicularly to the plane of the outlet. As no bones are to be penetrated make a short exposure. The distance of the tube from plate may be suited to the thickness of the parts. Simply have about eight inches between the tube-wall and the tissues.

Refer to section on photographic screens for shortening exposure-time. In these cases richness of photo-chemical action on the film is more important than high penetration or the fine details desired in certain negatives of bones, and the slight graining of the tungstate is not a drawback. Those who secure a really fine photographic screen to-day will be surprised to note how very slightly it marbles the negative.

Although the detection of vesical calculi is generally very easy by ordinary methods, yet the author had a case in which the ablest surgeon in a large city was not successful till repeated examinations were made and the patient so debilitated that when the final attempt detected the stone and an operation was done he died in two weeks. There are also special applications of the X-rays that are valuable,



such as the detection of encysted and multiple calculi, the determination of the presence of calculus in conjunction with an enlarged prostate, and in cases where there is mechanical difficulty in the way of employing the usual sound. The fact that a mechanical examination is not painless and is no more certain than a painless, harmless, speedy, and very accurate X-ray exposure indicates the growing value of the latter. Further perfection in technic will no doubt make it the only method in vesical cases. The number of successful radiographs of vesical calculi made in 1901 was very large and demonstrated the practical utility of X-rays in this field.

## CHAPTER XXXIII

### DENTAL SKIAGRAPHY

USES. TECHNICS IN FULL. LECTURE STUDIES.

THE first section of this chapter has been prepared especially for this System of Instruction, by C. Edmund Kells, Jr., D.D.S., of New Orleans, La., to whose painstaking care in presenting the subject the author is much indebted.

It being impossible to insert each Instruction Plate in the place in the text designed by the author the reader will refer to the series in proper order upon separate pages in the section. No other treatise has given dentists such plain directions for radiography as will be found in this presentation by Dr. Kells.

"Immediately upon the announcement of his discovery by Professor Roentgen the dental profession recognized the value of the new art of skiagraphy as applicable to their own and at once commenced its study. Up to that time any abnormal conditions existing within the alveolar processes were diagnosed entirely by the judgment and experience of the dentist, which naturally were not infallible, and a difference of opinion relative to a given case could easily be found between men of equal standing. But with the aid of the X-rays all such cases may be removed from the realm of doubt into one of exact knowledge, by which the diagnosis and prognosis are rendered positive. While some operators have constructed small fluoroscopes for use within the mouth, and others have contrived modified forms of Crookes tubes for projecting the rays from within outward, we may safely assume that the chief practicable application of the Roentgen ray to dentistry is through the art of skiagraphy, and its uses are as follows:

"1. In Orthodontia, revealing the position of un-erupted teeth.

"2. In cases of the non-eruption of the full complement of teeth, their absence from, or presence within, the alveolus may be demonstrated.

"3. By obtaining correct outlines of the root or roots of impacted third molars their extraction is rendered much less difficult, and frequently such teeth that would otherwise most certainly have been broken are now successfully removed through such information obtained.



"4. Teeth with abnormally shaped crowns are frequently unrecognizable, and whether they are deciduous or permanent can only be ascertained by the shape and number of their roots. Skiagraphy, and it alone, renders the diagnosing of such cases possible.

"5. The extent of an abscess may frequently be clearly exhibited by a skiagraph, and its treatment rendered more intelligent in consequence.

"6. The conditions which obtain about the roots of implanted and replanted teeth may be studied, which is most interesting and instructive.

"7. Whether or not an instrument unfortunately broken off in the root-canal protrudes beyond the apex may frequently be determined by a skiagraph; which knowledge is of the utmost value.

"8. Whether or not the root of a malformed tooth is of sufficient size as to warrant a crown being attached is ascertainable, and thus such an operation not performed unless its success is assured.

"9. Fragment of roots lying completely within their bony sockets, the size, shape, and position, or even existence, of which are not otherwise ascertainable, are plainly shown upon the skiagraph, and thus their removal rendered much more feasible.

"10. For discovering supernumerary teeth.

"11. Not infrequently a person will receive a fall, or blow, by which the front teeth are loosened in their sockets, or their roots fractured, and which of these has occurred is sometimes most difficult to decide, as manipulation of the parts is most undesirable. In such a case a skiagraph may set one's mind at rest, and dictate the treatment necessary.

"12. The apical foramen of a root may be unduly large, or a drill may have been allowed to penetrate too far, in either case it is rendered difficult to close this opening without allowing the filling material to protrude too far; or, perchance the canal may not be filled to its fullest length, both of which circumstances would prove fatal to the success of the operation.

"In such cases we may proceed as follows: After the preparation is completed *a lead post as large as possible is carefully inserted to the supposed proper depth*—that is just to the end of the root. This is cut off at the opening into the tooth or root-canal, whichever is most desirable, and sealed in place with temporary stopping. *A skiagraph is then taken* by which it will be clearly seen whether the post protrudes beyond the apex, is not long enough, or is just right, and the continuation of the operation proceeds accordingly. Thus having noted that the new art of skiagraphy does much for the advancement of the science of dentistry, we will proceed with the technique of the work, limiting ourselves entirely to the methods used in practice by the writer.

"It should, however, be borne in mind that in dental work we do not get the contrast between tooth and the bone surrounding it that may be obtained in other parts of the body where bone and

flesh are in opposition. In many cases distinct and clear pictures of the roots of teeth may be obtained, but in others (owing to the conditions obtaining) only the faintest outlines may be seen, and while these are all that may be necessary for diagnostic purposes they will not bear reproduction for satisfactory illustrations. Success in skiagraphy is entirely a matter of experience and attention to details; it being largely dependent upon the art of photography. If one is not more or less of an amateur photographer and familiar with the processes of developing and fixing a plate, and capable of printing a picture, it would be best for the beginner to *see this done in all its stages—not once, but several times—by an expert in that line.*

"In the question of the choice of a generator of X-rays I was guided by the fact that the alternating current was available, consequently I selected a 'Tesla Coil.' During the five years since its installation it has required but a minimum of care, and has always responded to the closing of the switch. The circuit breaker is simple and efficient, and water rheostats are used because of their capacity for minute graduations of the current.

"It is possible that tubes used upon a Tesla Coil are more liable to puncture than when used upon any other form of generating apparatus. Be that as it may, I was annoyed greatly by this trouble, obtaining no assistance upon the subject from the manufacturers, who appeared to be entirely at sea in the matter. Upon a close study of the workings of the apparatus I finally concluded that a certain pole of the coil, strange as it may seem, appeared to have a higher potential than the other, or at any rate the phenomena at that pole were in marked contrast to those to be observed at the other. To this 'positive' pole, as we call it, the terminal of the tube *away* from its stem is connected, and the connection nearest to the stem, of course, to the other pole.

"Next a wire is grounded and so secured as to have its free end poised near the stem connector of the tube and more or less adjustable, so that the distance between the end of the wire and the tube terminal may be regulated as needed. Under ordinary conditions when running there is always more or less sparking between the tube terminal and the stem, and I concluded this was the cause of the puncturing. But under these modified conditions the current leakage is diverted to the grounded wire and so avoids the risk to the tube.

"Whether this theory is correct or not I cannot say, but I do know that I have had no puncturing of tubes since I devised this feature.

"Fig. 1 shows the corner of my laboratory in which the work is done. The Tesla Coils contained in their oaken boxes are shown upon the left, with the circuit breaker in a box against the wall upon their right. A generous-sized fluoroscope (the one shown is 10 × 12) is better for general purposes.

"An old type-writer table at hand was first used to hold the tube-stand, and has proven so satisfactory that it has never been replaced



by a more modern contrivance. The tube-stand has two clamp arms, the one for the tube, the other for the 'Tesla screen.' An ordinary LeClanche battery-jar containing water slightly acidulated with sulphuric acid, and two electric-light carbons capable of vertical adjustment, form the very satisfactory regulator for the circuit breaker; and a Western Union jar fitted with one copper and one adjustable carbon electrode, with the same solution, governs the current supplied to the coil. In the shelf above large holes are bored which are fitted with cork cylinders, affording a safe method of holding the tubes out of harm's way. An ordinary piano-stool, the seat of which may be raised or lowered, and a photographer's head-rest, I have found the best means of getting patients into comfortable and satisfactory positions, and holding them therein. The tubes used are the best that can be procured. The next subject for consideration is the sensitized surface upon which the skiagraph is to be recorded.

"For this purpose the ordinary photographer's glass-plates, celluloid-films, and bromide papers, to be found among photographer's supplies, are available; but, *better than these, for dental purposes, are some celluloid films coated with a specially prepared emulsion particuallly well adapted to the action of the X-ray.* While glass-plates prove satisfactory upon flat surfaces, the flexibility of the celluloid allows its adaptation to the curvature of the mouth, consequently the latter is preferable. Again the glass is cut with more or less difficulty, which is an objection not found with the celluloid. The bromide paper possesses the advantage of giving the finished picture in one operation, but also the objection that numerous 'prints' cannot be made from it, as from the transparent skiagraph.

"In ordinary photographic processes the production upon the gelatine film is a 'negative' from which 'positive' prints are obtained, while in skiagraphy the reverse obtains; the X-ray film is a *positive*, consequently prints therefrom are negatives. If for any reason positive pictures are desired they may be obtained by placing the skiagraph in a printing-frame in contact with a *plate*, and exposing this to the light for the required length of time to produce a good negative. This is then developed, fixed, etc., and, when completed, prints obtained therefrom are positives. In Fig. 2 we have above an ordinary picture printed from a positive skiagraph while below is shown a 'positive' print made in the manner described.

"Naturally the sensitized film must be protected from both ordinary light and *moisture* during its exposure in the mouth, for which purpose it must be enveloped in some material which must of itself be transparent to the X-ray, and yet possessing these other requisites. In many cases an envelope may be made of black paper (in which the films or plates come wrapped) with its edges pasted down. If there is danger of moisture (in lower cases, for instance) this may be again wrapped in water-proof paper or gutta-percha tissue, all of

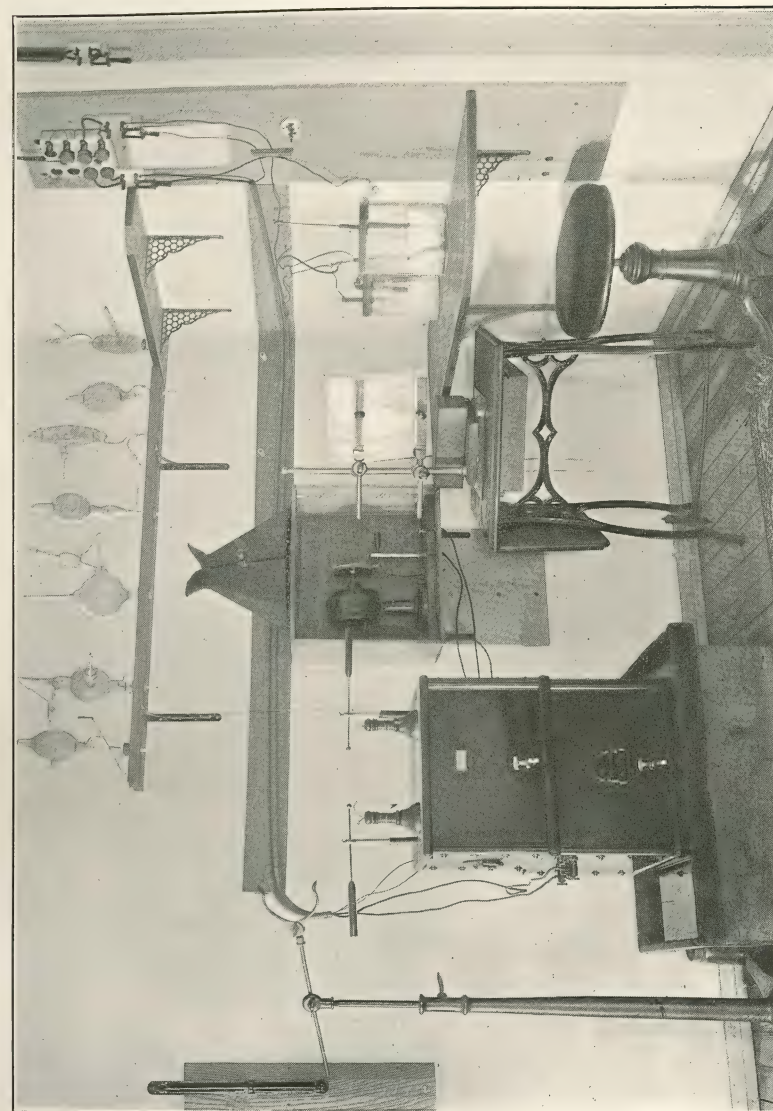


PLATE 133.—Plate 1 of Dental Series, showing corner of the author's Laboratory in which his X-ray work is done.



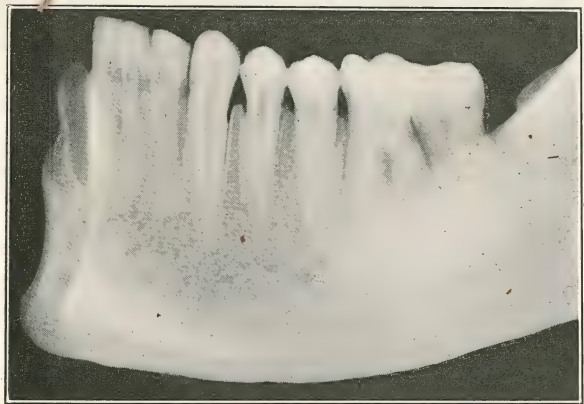
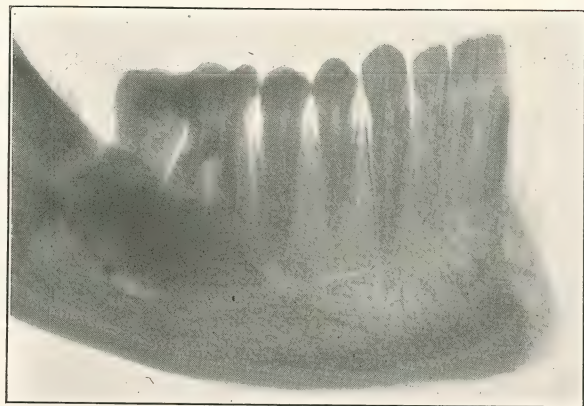
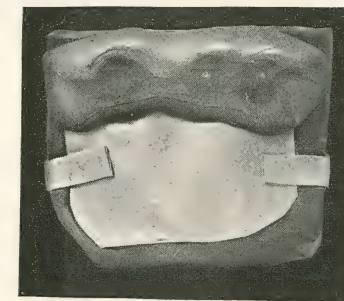
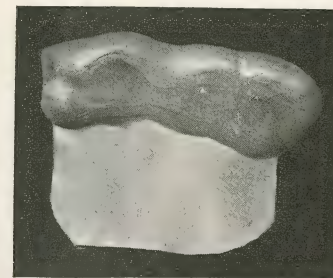


PLATE 134.—(2) The upper plate shows an ordinary picture printed from a positive skiagraph, while the lower picture shows a "positive" print made in the manner described in the text for Figure 2.



(3) Model of the upper teeth of a youth at 14, in which a cuspid is missing and long overdue.<sup>2</sup> In all probability it is dormant within the alveolus, and requires a radiograph for diagnosis as per description in text.



At the left in this plate is seen the film-holder made for radiographing the above case. At the right is shown the holder with the film attached and held securely by the two side clamps. (Figs. 4 and 5 of the text.)



This plate (Fig. 6 of the text) shows the picture obtained and clearly outlines the crown of the missing cuspid lying well toward the median line of the root of the lateral. See text for treatment.

PLATE 135.



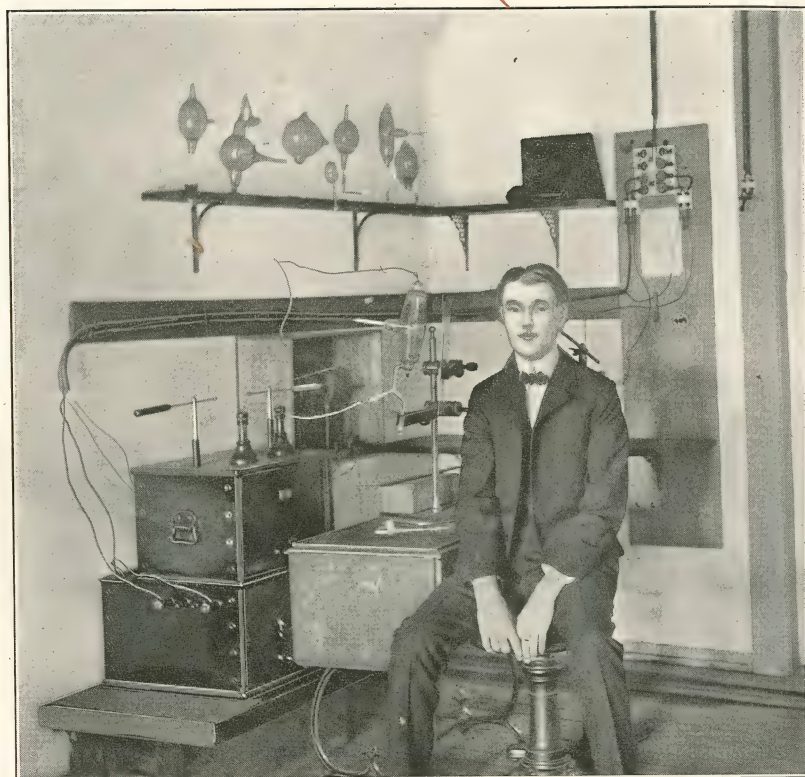


PLATE 136.—This plate (Fig. 7 of the text) shows the position of the patient with the film in his mouth in readiness for the exposure which made the above radiograph. The grounded aluminum screen shows faintly between his face and the tube. In altering the face of the subject to disguise the identity the reproduction has unfortunately shifted the correct pose of the head with relation to the tube. The picture will, however, give a sufficient idea of the work for others to follow. Some pose the patient in the regular dental chair, which affords a steady head-rest with an easy semi-recumbent position. A variety of tubes is seen in the rack above the apparatus. The various wire connections are shown with instructive distinctness. With the aid of the text of this chapter any dentist should be able to succeed in radiography.

which are practically transparent to the X-ray. A very convenient covering, however, and the one which proves satisfactory in most cases, is the ordinary black dental rubber, which is at once both light- and moisture-proof, and is at the same time most easily handled. Of course the rubber which is furnished in the thinnest sheets is preferable. Folding this over the film and pinching the edges together seals it perfectly. In this case the gelatine surface must be protected from contact with the rubber by a piece of tissue-paper, or what to my mind is better, as will be explained later, two films may be used put face to face.

"We must bear in mind that in order to procure a skiagraph with perfect outlines the patient and the sensitized film must be held immovable during the time of the exposure. In many cases the patient or an assistant may hold the prepared film in place in the mouth, but in some special cases this may not prove satisfactory, when a *film-holder should be made as follows*: Over the crowns of the teeth to be skiagraphed is moulded a thin layer of modelling compound, to which is attached a piece of aluminum plate about twenty-eight gauge, and of such size and shape as to cover the region to be skiagraphed. The edge attached to the compound being slit every one-eighth of an inch or so, and the little pieces bent so as to secure a better hold in the compound. The aluminum is bent to conform to the mouth and lay as snugly against the mucous membrane as possible. To this is attached the prepared film by small U-shaped clamps of aluminum about one-eighth of an inch wide and long enough to hold the two together, when pinched down with pliers, as will be shown later.

"When this is placed in the mouth the patient should close upon it with the opposite teeth, thus holding it securely in position. At the same time this very act of closing his mouth places him in a very comfortable position, allowing him to swallow, and, in case of necessity, he can remain immovable and comparatively comfortable for a considerable length of time.

"Having proceeded thus far it will probably simplify matters for us to take a case in practice and carry it through from beginning to end. In Fig. 3 is shown the model of the upper teeth of a young man of fourteen in which it is seen that a cuspid is missing, and long since overdue. In all probabilities the tooth is lying dormant within the alveolus, consequently we will proceed to skiagraph the case that it can be treated more intelligently. Fig. 4 shows the film-holder made for the case. (See Plate No. 135.)

"In Fig. 5 is shown the holder with film attached, held securely by the little clamp at either end; while in Fig. 6 is shown the picture obtained, clearly outlining the crown of the missing cuspid lying well toward the median line of the root of the lateral. The treatment therefore indicated is to push the first bicuspid back against the second, rotate and bring the lateral into its proper position in the arch, and drill out fully and deeply the bony tissue to the labial or



rather buccal side of the cuspid, which will naturally fall into the space thus made, and erupt in the proper or very nearly the proper position.

"In Fig. 7 is shown the patient in position, with the film attached to the holder in the mouth and all in readiness for the exposure.

"Between his face and the tube is a 'Tesla screen,' a thin plate of aluminum 'grounded' to the gas-pipe by a fire wire. Now I do not believe it possible, from the history of X-ray burns which I have read, and from my own experience, for any such to occur during the short exposure to which we submit our patients, but the screen is used for two reasons—the one upon 'general principles,' which should always cause one to take every precaution for his patient's good, and the second, to protect his face from flying fragments if perchance a tube were to break, of which I have read but never experienced. Thus the screen does double duty in protecting both operator and patient.

"In 'posing' the patient it must be borne in mind that the best results can be obtained only when the object to be skiagraphed is at right angles to the rays from the tube, and the film parallel to, and as near, this object as possible. This renders such results obtainable only upon the posterior teeth when the vault is high in upper cases, and in lower cases when the floor of the mouth is deep, and the processes straight. All other cases, and the anterior teeth where the film must be curved, give only distorted pictures, which, however, are frequently all that are needed for diagnosis.

"The exposure completed (which is best accomplished in a darkened room that the behavior of the tube may be followed), the length of which in each case depends upon the efficiency of the tube at the moment of use, and the thickness of the bone to be penetrated, varying from twenty seconds to one and one-half minutes, we transfer our scene of operations to the dark-room where the 'development' of the film is proceeded with. Successful work of this character, as before stated, depends entirely upon the experience and skill of the operator; assuming, of course, that his apparatus is sufficiently efficient. Nor do I believe that any one can learn any but the rudiments from reading—one should have it demonstrated if possible, and then practice until proficiency is reached.

"In order to learn what details of technic produce good results, and what produce failures, a careful record of each case should be noted, from which comparisons can be made.

"It being desirable to keep our skiagraphs systematically and conveniently, what better method of preservation of both it and its records could there be than an envelope specially prepared for this purpose? In Fig. 8 is shown a plain manila envelope printed as desired, which we date and number when case presents, and as soon as the exposure is over we enter the necessary notes. (Plate 137.)

"With each class of sensitized films, for there are many with varying qualities, full directions for developing accompany them;

the only choice we should have in the matter, other things being equal, would be the selection of a formula that does not stain our fingers in preference to one that does, if both are given, which fortunately usually occurs. 'Pyro,' which appears to be the favorite with professionals, does stain very badly, consequently should hardly be used by the dentist, for it is almost impossible to use these solutions and keep the hands entirely free from them. Metol-hydrochinon, which is a favorite with many manufacturers for use by 'amateurs' has many advantages, does not stain, and is used almost exclusively in my work.

"I rarely take a *single* skiagraph for reasons which will be shown later, but *superimpose* two or more films upon each other, arranging them so that the gelatine surfaces are not in contact with the protecting envelope if it be of rubber. The plural films having been exposed, we now go into the dark-room, where our vessels and trays are conveniently arranged as shown in Fig. 9. I have found that an ordinary photographer's 'clip' is most convenient for handling these little films and prints, as by them they can be carried through their various processes from start to finish without any handling by one's fingers, and without touching their sensitized surfaces.

"One set of clips so plainly marked as to be recognizable in the dark-room should be used for developing only, after which the film is transferred to another clip by which it is carried through the other processes. In the dark-room two features are most important, the first, having a *perfectly safe* 'ruby' light, and second, absolute cleanliness of the vessels employed.

"Upon the left of the picture of my dark-room is shown an *ordinary saucer*, which I find most convenient for developing such small films as we use for dental purposes. This process is commenced preferably with some old solution that has been used before, and, consequently, weakened; or, if this is not at hand, fresh solution is used, diluted with one-fourth its volume of water. A sufficient quantity of this is poured into the saucer and the several films placed therein, *face downward*, the saucer being rocked while the process is watched. In a few moments they are *turned over*, and when somewhat darkened the developer is poured off and thrown away and *new* solution flowed on. One of the films is then caught up by an unimportant corner in a pair of clips and the process continued, the film being held before the light from time to time to see its progress. When it is considered fully developed it is thoroughly rinsed in the little jar of water next to the saucer by whisking it up and down a number of times, when it is caught by another clip, and by this one hung in the next jar, which contains the fixer. (See Plate No. 138.)

"We then go back to our other films, catch one of them by the first (developing) clip, keep it moving in the solution for a full minute, *slit one corner with scissors for a depth of one-eighth inch or so*, then rinse, transfer it to another clip, and hang it in the fixer. This process is repeated with the other films which are slit in turn 2, 3,



or 4 times as may be necessary, and which will in all probability be considered ruined by over-development.

"Once the films have been whisked around in the fixer so as to be sure the solution touches every part of their surfaces, the light may be turned on. We now allow these to hang in the acid fixing bath, composed of the formula recommended by the makers of the films, from fifteen to twenty minutes to assure their preservation, and then transfer them to the washing jar, which is seen in the sink. This consists of an ordinary Western Union battery jar, with a notch about three-eighths of an inch wide and the same in depth, ground out of its upper edge. In this is hung a bent glass-tube, its inner end having a piece of rubber tubing attached, which reaches to the bottom of the jar. Upon the outer end another piece of tubing extends an inch or more only. The jar is first filled with water from the tap above, which starts the syphonic action through the bent tube, when the tap is almost closed, only allowing a very small stream to run. The films are thus most thoroughly washed, the heavier solution of the 'Hypo,' as it falls to the bottom of the jar, being carried off by the rubber tube. Most thorough fixing and washing is necessary in order to insure the permanency of the skiagraph. Thin films, such as are used in the Kodak, may be fixed in ten or fifteen minutes, and washed in one hour in such an apparatus, while the double- or triple-coated films, made specially for X-ray work, *require double this time* for each process.

"When the washing is completed the Kodak films are transferred to the jar upon the left, which contains the glycerine solution; in which they are hung for five minutes, after which they are hung upon the wire above to dry. The object of the glycerine is to prevent the films from curling while drying, which they otherwise would do. The flat heavy films do not need this precaution, but are taken out of the water and hung up to dry. During hot weather all solutions should be used ice cold to prevent the films from being spoiled by 'frilling,' and it is advisable to hang the films in a saturated solution of common alum in water for five minutes to harden them. They must also be washed in cold water or the change of temperature may cause 'reticulation' of their gelatine surfaces, which would also spoil them.

"The manufacturers of plates and films furnish instructions for 'intensifying' negatives, but I must admit that as far as skiagraphs are concerned I have never been able to succeed in improving them by this process. The drying of the films is a tedious process requiring hours unless they are hung in a strong wind, but it may be hastened as follows: After being washed the film is placed in *absolute alcohol* for about five minutes, taken out and *hung before an electric fan where it will dry out in a few moments*. Of course the smaller the skiagraph the quicker it will dry. Having carried our three or more duplicate skiagraphs through these various steps, and, finding them finished, we are able to recognize which were developed the longer,

and which the shorter, *time by the number of slits made in them*, and the *probabilities* are that the one which was allowed to remain the longest time proves to be the best.

"*The point at which to stop the development is most perplexing to decide, and this method was devised to tide me over this difficulty, and I can but believe it has distinct advantages over the taking of the single skiagraph.* As soon as the skiagraph is put in the washing jar we turn to our recording envelope and complete the details as to the developer used, etc., and enter any explanatory notes that may be pertinent. The next step is to obtain the print or picture from the skiagraph, which is rendered comparatively easy by the introduction of the *developing papers* capable of being worked by artificial light.

"Having decided upon a brand known as 'Velox,' we prepare the formulas recommended for its use by its manufacturers, and proceed very much as we did with the original skiagraphic film. Under dim light (either day or artificial) we cut the paper to the desired size and place it over the film (the back of which has been wiped off so that it is perfectly clear) in the printing frame, being careful that the gelatine surface of the film is uppermost, and the sensitized surface of the paper, which is recognizable by the very slight curling of the paper toward it, is downward, and expose it to the light as per directions supplied. It should be noted that when two or more films are superimposed upon each other that those with the gelatine surface *away* from the part skiagraphed will show the picture reversed *unless printed backward*, which should be done.

"Sufficient developing solution is placed in a saucer, the paper caught up by one corner by the clip and immersed in cold water for a few seconds and then laid *face downward* in the solution, the paper being slid in edgewise that no air bubble will form upon the surface, and the saucer gently rocked. It is almost immediately reversed so that the development, which takes place at once, may be carefully watched, the paper being always kept well covered with the solution and the saucer gently rocked. As soon as it reaches the proper degree of clearness it is quickly plunged into the jar of clear water, whisked up and down a few times, and then hung in the fixing bath, being sure to change clips for the purpose. After it has been well fixed it is washed for an hour, as was the film, when it is ready for mounting.

"The card as shown in Fig 10 affords a convenient mount which, at the same time, contains all the information relative thereto that needs be known for an intelligent understanding of the case. These should be put in an album, and thus maintain at ready access a complete record of one's work. Very frequently a patient desires a print, in which case it would probably be better to mount it upon one of the small embossed cards intended for Kodak pictures.

"The following are a few details that should be firmly impressed upon one's mind:

"Do not expose the films to even the ruby light unnecessarily long.



"Do not allow the least particle of the fixing solution to get into the developer.

"It is best to make up the solutions needed from fresh chemicals, rather than to use the prepared 'tubes' sold in the market, and use distilled water.

"Clips that are used for handling the films in the fixer may be used for washing them, but for no other purpose. Those used for developing should be plainly marked.

"Glass vessels may be used indiscriminately for either solutions, but must be most thoroughly washed.

"The developing solution of Metol-Hydrochinon can be kept for weeks in small, say four-ounce well-stoppered bottles, filled right up to the corks. When it becomes discolored it should be discarded.

"The acid fixing bath will also keep for several months, but should be decanted when necessary. Finally, after continual usage it loses its strength, when it should be discarded.

"In order to test a film, or plate, to ascertain if it is still good (for they do not keep indefinitely) proceed as follows: Cut off a small piece, and, placing it in the developing solution, treat it as if it were an exposed plate. After allowing it to remain in the solution a few minutes rinse and fix. If it comes out of the fixing bath perfectly clear that is proof positive that it was good—if not clear, that it had deteriorated and should be discarded.

"If a film fades out after fixing it is an evidence of not having been allowed to remain in that solution a sufficient length of time. The rule should be to allow the film to remain in the fixing bath twice as long as it requires to clear the back of its whitish appearance.

"Sometimes one's printing paper (Velox) becomes spoiled. If there are any doubts about it, it may be tested in the same manner as the film.

"Referring now to the figures in our Instruction Plates we have an illustration of the use of the skiagraph as applied to Orthodontia which has already been given in Fig. 6. Fig. 11 represents a model of the lower teeth of an adult, in which one incisor is missing, and upon the right the skiagraph showing its absence from the alveolus. Class 2. Fig. 12 is a case of an impacted lower third molar, and the skiagraph of the same, by which its removal was rendered easy; besides which is shown the tooth itself after extraction. Class 3.

"In Fig. 13 a model of the lower jaw is shown, in which was placed in its original position, the third molar after its extraction, and which extraction was rendered comparatively easy by the skiagraph shown. Class 3. Fig. 14 represents the lower teeth of a miss of fourteen, in which is shown an abnormally shaped second bicuspid, and upon the right the skiagraph of the same. That it has a single root proves it to be the second bicuspid and not the retained temporary molar, which tooth would show bifurcated roots. Class 4.

"In Fig. 15 is shown a skiagraph of a lower incisor, around which it is seen that the alveolar process has been entirely destroyed by an

abscess, besides which the apex of the root has been absorbed. Class 5. Fig. 16 shows a *second* molar which was extracted and replaced, and the accompanying skiagraph *taken one year later* shows the roots perfect, no absorption having occurred. Class 6.

"Fig. 17 shows indistinctly, on account of the flatness of the arch, the root of a first upper molar in which a broach has been broken off. Class 7. Fig. 18 represents the model of an adult showing a malformed left upper lateral, and the skiagraph which shows the root of sufficient length as to justify a crown. Class 8.

"Fig. 19 is a reproduction of a root which was *crowned and tubed* in order to share with its mate upon the opposite side of the arch in carrying a set of nine teeth, which it failed to do except for a short time. Had this been skiagraphed beforehand it is probable that it would not have been so taxed. This case comes under Class 8. In Fig. 20 upon the left is shown the remains of a third molar which had been '*extracted*' one year before, and which was entirely invisible, being covered by the gum, yet easily extracted by the aid of a skiagraph, after which it was placed in the model in its original position. Upon the right is a skiagraph of an invisible root of a lower bicuspid, which was readily removed. Class 9.

"Class 10. A very interesting case, the duplicate of which I have not seen recorded, came under my observation and is shown in Figures 21, 22, 23. The subject was a child of twelve, the model showing the left central unerupted, and no signs of it could be discerned. Naturally the adjoining teeth had approached each other so that the vacant space was about two-thirds the width of the *erupted* central. A skiagraph showed the missing central well up within the alveolus. In addition to the shadow of the central, and a little above it, was shown a peculiar shadow which we presumed to be a defect of some kind. A second picture was then taken in which this peculiar shadow again came out quite well marked, and after some thought I concluded it was a supernumerary tooth, and so stated. Space was made by separating the left lateral and right central to the necessary extent when in due time the missing central appeared, and finally was fully erupted. In the meantime the supernumerary tooth also came down, and so bore out the testimony of the skiagraph taken nearly eighteen months before.

"In Fig. 24 is shown the skiagraph of the upper incisors of a little miss of twelve. Two weeks previously she had received a violent blow in the face, and when she presented the left central was elongated nearly one-eighth of an inch, and the right nearly as much. The former was so loose that it was impossible to decide whether its root was fractured or not. The skiagraph demonstrates that the root is intact and that the injury is mostly to the process. Class 11.

"A lad of seven presented himself with the corner of an upper central broken off, caused by a fall. The shock to the tooth was so severe that the pulp died. Upon opening to the canal it was found that a piece of orange-wood fully one-sixteenth of an inch in diameter



could be pushed through the foramen, and, naturally, to fill that root satisfactorily was almost, if not quite, an impossibility. A lead post was trimmed until it could just be forced through the end of the root, and by gentle manipulation it was finally decided that in a certain position it was about the desired length. It was then cut off *even* with the surface of the tooth, sealed in place with temporary stopping, and a skiagraph taken. This unfortunately was spoiled after it came from the fixing bath, but in the meantime I had seen that the post protruded slightly beyond the end of the root. It was therefore withdrawn, shortened the required length, and was then used to carry the gutta-percha root-filling to place, and allowed to remain in the tooth permanently, thus assuring me that the filling did not protrude beyond the root. Class 12.

"Skiagraphs of the antrum, or rather of a part of the antrum, may frequently be taken to advantage, but I do not include such cases in the true dental classes."

"Thus we have seen that the applications of skiagraphy to dentistry are *varied and numerous*, and, above all, *most satisfactory*. Consequently, *we may safely assert that in our specialty we cannot do our patients full justice or hold our own in the line of our profession, unless we give them the benefit of this new science.*"

Following the technical directions given above by Dr. Kells, we append further matter calculated to inform both dentists and medical practitioners of the immense value of X-rays in this field of scientifically directed work. These cases have been published before, but are *not the less instructive* on that account. Transplanted to these pages they will meet eyes that would never otherwise see them, and certainly every surgeon, physician, and all who have teeth, should be made aware of the important facts. Therefore, without excuse or apology, we take these studies from current literature and insert them here.

"While the X-ray in dentistry is not usually employed in cases in which it is 'a matter of life or death' to the patient, its more frequent utility gives it a value of a high order, and its dental applications, while confined to a comparatively small portion of the body, are of rather wide range and will require as much skill on the part of the operator as work upon thicker tissues. For instance, the dentist must be able to so manipulate his tube and technique as to differentiate between the roots of the tooth and the bone which surrounds them, a task equal to any which confronts the physician. This is difficult, because as the root grows smaller toward its apex the bone proportionately thickens about the socket. Or, on the other hand, the dentist may have before him simply the location of a broken broach or a pus-cavity, tasks which are comparatively easy."

"The most frequent uses for the X-ray in dentistry, as brought out by Kells, Rollins, Price, and Clapp, are for locating unerupted

## DENTAL SKIAGRAPH

by

Dr. C. Edmund Kells, Jr.

No. .... Date .....

*M* .....

Age .....

Examined for .....

Make of Plate .....

Time .....

Distance .....

Developer .....

Tube .....

Remarks .....

PLATE 137.—Plate 8 of the text, showing form of envelope for filing and recording dental skiagraphs.



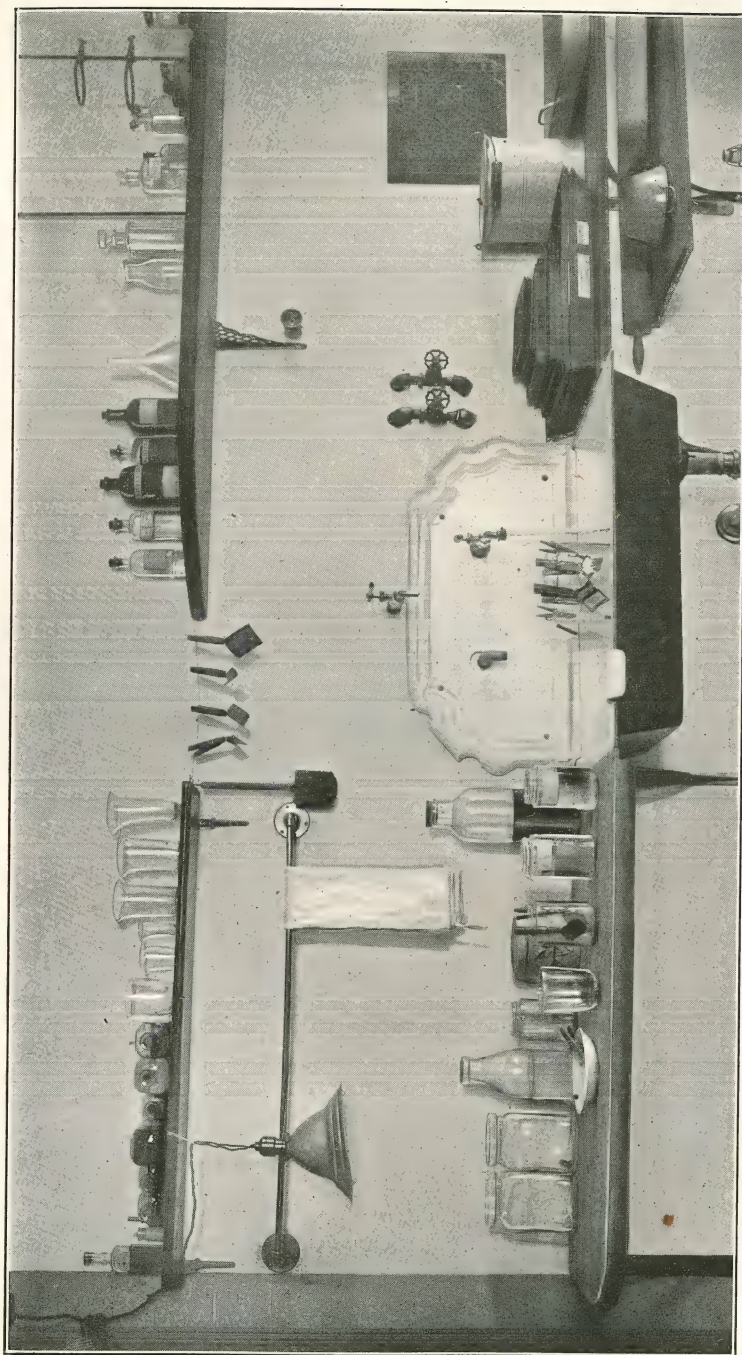
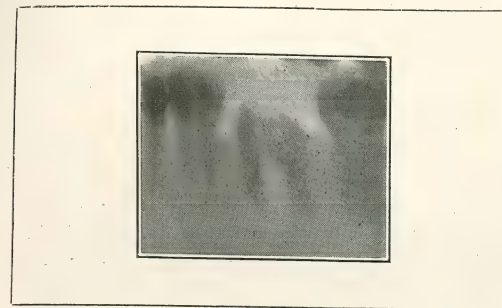


PLATE 138.—(9) Showing accessories for developing films as described in the text.

# DENTAL SKIAGRAPH.



By DR. C. EDMUND KELLS, Jr.

No. 523 Date May 26-1901  
 Of Mrs H. W. B.  
 Age Adult Upper Lower  
 Examined for Molar root fillings  
and extent of abscess.  
 Make of Film Seel's Special  
 Distance 12" Time 1 Minute  
 Tube Gen'l Electric  
 Developer Metal-Hydro.  
 Notes \_\_\_\_\_

PLATE 139.—Fig. 10, showing a convenient card-mount with author's manner of filing record of the patient and radiograph. When filled and filed in an album for ready reference with an index, a given case may be found at will.



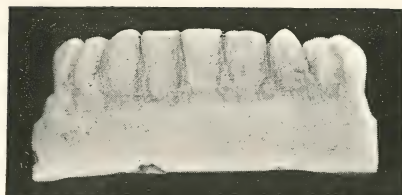


Fig. 11. At the left is a model of the lower teeth of an adult in which one incisor is missing, and on the right is the radiograph showing its absence from the alveolus.

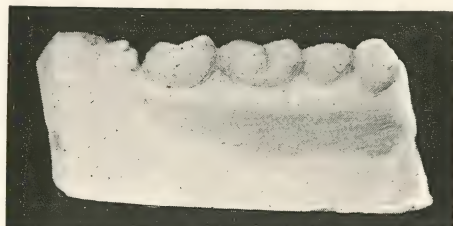
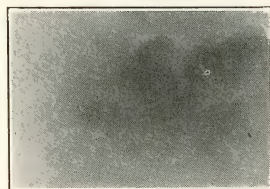


Fig. 12. Model of an impacted lower third molar.



On the left is the skiagraph of the above tooth, by which its removal was rendered easy. On the right is a photograph of the same tooth after removal.

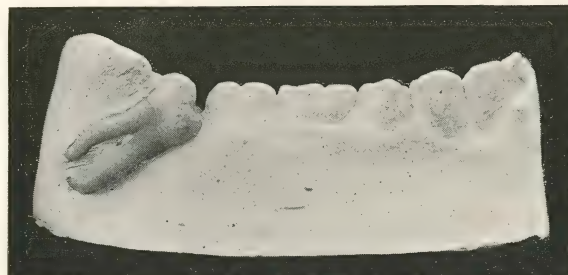


Fig. 13. Showing a model of the same lower jaw in which the same tooth is replaced after extraction to illustrate the difficulties which the radiograph solved.

PLATE 140.

teeth, for ascertaining their position and the shape of their roots, for diagnosing fractures of the jaw, for locating foreign objects, such as a broken broach, for determining the depth of a root-filling, the presence and extent of an abscess, and the proportions of the antrum. The successful practice of X-ray work requires modern appliances, and a manipulation of them calls for one who is expert and accustomed to mechanical detail. To this extent the dentist is well fitted by the nature of his mechanical and digital acquirements at the very outset. Moreover, X-ray work being an electrical process, the majority of dentists are to a large extent familiar with the fundamental electrical requirements, and are all ready equipped with many appliances which may be used in the work. My best dental cases have been taken in from three to ten seconds, and the antrum in from ten to fifteen seconds. This compares with taking the hand in forty-five seconds, and the thorax in four minutes.

"Much has been said as to the best methods of preparing the film for a skiagraph. Ordinary film is used for this purpose. One encloses it in black unvulcanized rubber. Another wraps it in paper with the edges glued. In taking a picture of the lower jaw in mouths profuse with saliva, and with a small coil which requires a minute or so exposure, the rubber wrapper is invaluable. But with a large coil with which the work can be done in a few seconds I have simply enclosed the film in two thicknesses of black paper. Two layers of paper are necessary to exclude the light, and I have not yet required so long an exposure that the inner layer was ever moistened.

"Before closing I will call attention to a class of cases in which the X-ray is of high value. It is frequently necessary to open into the antrum for treatment and drainage. For this purpose it is desirable to open at the most dependent point, and exactly flush with the floor. A point between the second bicuspid and the first molar is usually selected for this purpose, and a skiagraph taken through this region will indicate the exact point for making such an opening. This is an easy matter. A rather large piece of film is wrapped and placed well back in the mouth. It is held in contact with the teeth and palate, and *the tube is placed at an angle of about forty-five degrees up and back*. This will produce a picture with the least distortion of parts. The bone being rather thick, from ten to fifteen seconds will be required with the tube fifteen inches from the face. Less time will be required if the tube is nearer. An examination of recent skiagraphs will show with what precision this can be done. The beginner in X-ray work should make up his mind that he is entering a field that requires practice, and yet I know of no more fascinating work than this. From the turning on of the current to the printing of the skiagraph, it is teeming with interest, and no other procedure in dentistry gives more pleasure and profit to the operator than X-ray work." (CUSTER.)

"For preparing the plate or film for the purpose several methods have been suggested. To my mind, no method that I have heard of



approaches in convenience and simplicity the following: It consists in simply placing a large piece of specially prepared X-ray film, which is quite stiff, between two layers of unvulcanized black rubber, making the rubber touch around the edges where dentists know how sure it will be to cling. This can now be cut to the desired sizes with a pair of shears, and simply pressing the rubber together where you have cut seals a perfect joint. This is perfectly impervious to light and moisture, and offers almost no resistance to the X-rays. I put a piece of X-ray bromide paper also in with its face to that of the film, thereby getting a photo direct, and also protecting the sensitized surface of the film. Occasionally, it is an advantage to secure the plate with a special plate-holder, but very seldom do I think it desirable or necessary, the films prepared in the way I speak of are so convenient. You can bend a corner over anywhere, thereby making the film any desired shape or size, and, of course, the rubber adheres to itself and holds it firmly. The film can generally be held in place with a finger to get the best results.

"You will observe a number on each side of the slides exhibited. This is done by placing little figures on the outside of the wrapper over the film. They are made of fine copper-wire, prepared in advance, and stuck on with gum labels. It is a great convenience for keeping records without danger of getting negatives mixed.

"I have a very complete system of keeping all the records of each case, upon the envelope used as the negative preserver, which I will pass around. Note especially that the angles of the rays, the teeth, and the plate, to each other are kept in each case. This is very important and valuable since by it you can at any time determine the exact dimensions. Before proceeding with the practical cases I want to advise any intending investors to get a small glass-top table on large, rubber-tire casters, or wheels, for keeping your coil and accessories, which are few, upon. We will now see some lantern views of practical cases and one or two typical pictures will suffice in each of several classes of cases in which the Roentgen rays are specially well adapted for diagnosis. Unfortunately a great deal of the detail and information is lost as compared with looking through the negative itself. Photos, even contact prints, lose about half their detail. In good negatives even the cellular structure of the bone is distinctly shown. This is mostly or entirely lost on the screen or in the half-tone used for illustration, so you will have to make a great deal of allowance.

"For the location of unerupted teeth the X-ray is simply *perfection*. Fig. \* shows the condition of the superior arch of a boy at ten years of age. Two generations preceding, on his mother's side, had been lacking the superior laterals. She presented him to have steps taken to prevent the shedding of his deciduous laterals to make them

\* In joining together the following extracts from several interesting lectures by Dr. Price we have deemed it useless to insert the numerous small radiographs which show so poorly in reproductions, though his figure references have been left standing in order to keep the text intact.

permanent. You can scarcely imagine the joy of that mother, who herself suffers considerable disfigurement from this cause, when she saw the radiograph showing the development of these teeth that had been the object of her cherished but abandoned hope. The next figure illustrates the condition in a case of delayed dentition of the bicuspid. The cuspid has been erupted for some time and the first deciduous molar shed by this eruption. This superior arch is exceedingly retracted. The radiograph shows that but one bicuspid has formed, and it is thrown out of its course by about twenty degrees. It is absorbing the anterior buccal root of the first permanent molar. A course of treatment is quickly suggested.

"In the next figure is a typical example of the appearance of cases where a permanent tooth fails to form and the deciduous is retained. In this case an inferior deciduous molar. A lady of about thirty years of age discovered that she still had a baby tooth and felt so ashamed of herself that she hurried to the office to have it extracted. The radiograph settles all hope of it ever having a successor. I will now show you a wonderful picture demonstrating the very early calcification of the enamel of the permanent teeth. It is taken of the superior arch of a baby boy of fourteen months, who has no deciduous teeth erupted yet in this arch. The radiograph shows not only the development of all the deciduous teeth, but also the commencement of calcification of the permanent centrals. But this is not all. While his father is lacking his permanent laterals we can see clearly in the negative, which was a ten-second exposure, even at this young age the crypts forming for his permanent laterals. I know of the joy of that boy's father at this information, for he is my boy.

"An example of lost teeth is shown in the next figure, which indicates the whereabouts of the missing bicuspid. There are very many cases of this class. The next figure shows a lady's superior arch at about thirty years of age. When this picture was taken she was still waiting for her permanent teeth to erupt, but she need not wait longer, for this lone second molar is all she is to have on that side. Five teeth are lacking on that side and three on the other. In no class of cases is this means of diagnosis of more frequent service than for exploring the various deep pathological conditions. For example, the extent and location of abscesses, the direction and path of the fistula, and of very great importance, the most dependent point of the abscess. This next picture shows the appearance of a blind abscess at the apex of an inferior incisor. It shows which tooth is affected and that no teeth in this vicinity have root fillings to suspect as imperfect.

"In the next figure we have some information regarding a case of neuralgia of uncertain cause of years' standing undoubtedly caused, as proven later, by the blind abscess at the apex of the first superior bicuspid. The abscess was evidently caused by imperfect root-filling, which is clearly shown to only extend half way to the apex. On opening up the canal I found putrescence in the apical half of the canal. This negative shows beautifully the cellular structure of the bone.



The next picture, Fig. —, shows the same root filled to the apex. The blind abscess was drained through the buccal wall of the process. These abscesses vary greatly in extent and their exact extent is clearly shown in good radiographs, as for example in this picture, Fig. —, which shows a blind abscess of considerable dimensions, and of years standing, during most of which time it has been almost continually under treatment, so the patient informed me, through the root-canal of the lateral where it had its inception. In this next picture we have an exceedingly large abscess, and also one of long standing. It had a fistula beside the second bicuspid. The dentist sending the case for radiographing had labored faithfully, but with unsatisfactory results, to cure it. A crown on the lateral had been destroyed to examine the root-filling beyond it, and the second bicuspid had been extracted and replanted in search of exostosis. The radiographs taken in sections, show the root of the lateral to be largely absorbed and a series of pockets difficult to drain between the roots of the various teeth. It also shows the abscess to extend beyond the anterior buccal root of the first molar.

"The picture next before us shows a remarkable change of bone-structure taking place around a superior central incisor, one that had, a couple of years previous, received a hard blow, since which time it has been constantly elongating, though it is very solid in its attachments. The negative shows clearly the old base for the apex, from which it has advanced about three-sixteenths of an inch. It is an interesting study in pathology. The bone, though forming an unusually firm attachment, is evidently less dense than normal, and slightly honey-combed in structure. The peridental membrane is almost obliterated. In the next picture (Fig. 17) we have another blind abscess with its evident cause, viz.: Imperfect root-filling. The case was of thirteen years' standing and had received extended treatments. I amputated the tip of the root, without extraction, at the point where the root-filling ended as shown by the radiograph, and with splendid results. The next picture shows the same tooth after the root amputation. In the next picture we see how beautifully the bone has adhered around the stub of one of these amputated roots. This amputation was made in January, 1896. The patient claims it to be the strongest, solidest tooth she ever had. In the next we see a broken broach protruding through the apex far into the tissue.

"In this picture (Fig. 21) we see much of interest. The radiograph was taken to locate a piece of a cambric needle which the patient had broken in the root while trying to relieve an abscess. It was thought to have been forced through into the tissue as the apex was found open. It is easily seen lodged in the root, which was evidently bifurcated. This picture also shows beautifully the relation in this case of the teeth to the antrum. You will observe that the roots of the second molar penetrate nearly half way up through that cavity. The value of X-rays in Orthodontia is almost beyond

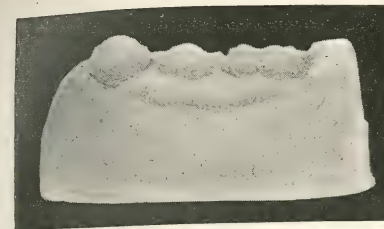


Fig. 14. At the left is the model of lower teeth of miss, aged 14, with an abnormally shaped second bicuspid. The radiograph on the right shows the same in situ as seen by the X-rays. Its single root proves it to be the second bicuspid and not a retained temporary molar.

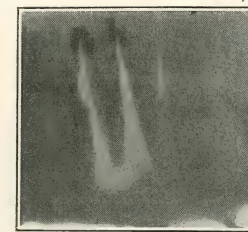


Fig. 15 shows a lower incisor. The alveolar process has been entirely destroyed by an abscess and the apex of the root has been absorbed.

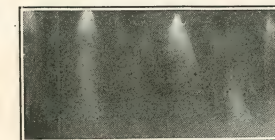
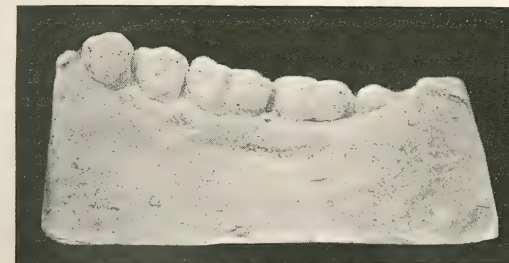


Fig. 16. The model shows a second molar which was extracted and replaced. The radiograph at the right was taken a year after and shows the roots to be perfect, no absorption having occurred.

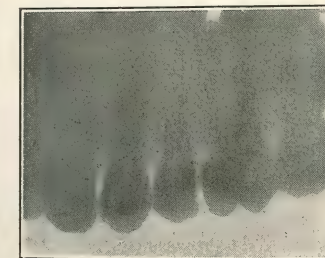


Fig. 17. This shows indistinctly in the reproduction the root of a first upper molar in which a broach has been broken off.



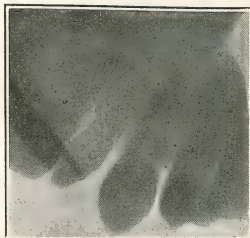
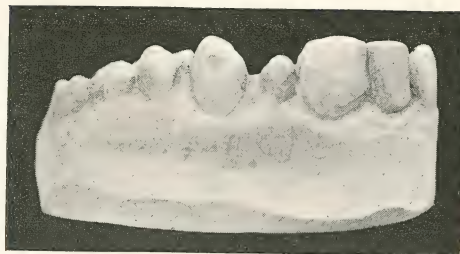
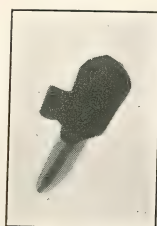


Fig. 18. The model at the left is that of an adult with a malformed left upper lateral. The skiagraph at the right shows that the tooth has a sufficient root to justify a crown



This (Fig. 19) is a root which was crowned and tubed to share with its opposite mate the support of nine teeth. It failed. Had it been skiagraphed first it would not have been so taxed.

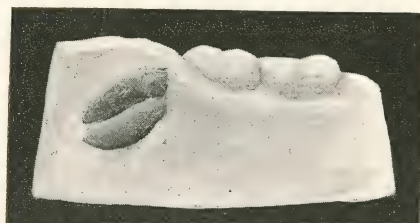


Fig. 20. The model at the left shows the remains of a third molar. It was supposed to have been extracted a year previous and was entirely invisible, being covered by the gum. By the aid of the skiagraph it was easily discovered and removed. The picture on the right shows the root of a lower bicuspid which was invisible to the eye. The X-ray made it easily removed.

PLATE 142.

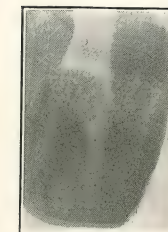
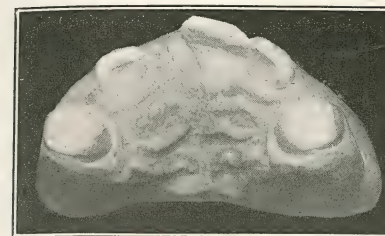


Fig. 21. At the left is a model showing the left central unerupted in a child of 12, and no signs of it could be discerned. The skiagraph at the right shows the missing tooth well up in the contracted space. The shadow of a supernumerary tooth was also revealed. Space was made and the central finally erupted. The supernumerary also came down and confirmed the skiagraph.

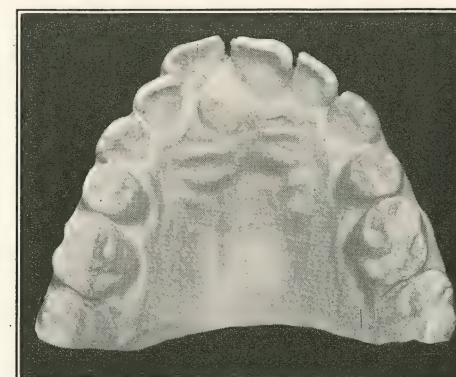


Fig. 23. This model shows the central erupted with the supernumerary tooth behind it. The model was made 18 months after the above illustrations and exhibits the beautiful certainty of working with the light of X-rays.



Fig. 24 shows the upper incisors of a girl of 12. She had received a violent blow and it was a question whether the root was fractured or not. The skiagraph demonstrates that the injury is chiefly in the process and the root is intact.

PLATE 143.



*calculation*, for it enables us to see just how our force is being expended. Probably the greatest factor in that work is to move the roots as well as the crowns. In this picture (Fig. 22) we see an attempt to draw two teeth together when alas only their crowns have been tipped toward each other. This next picture (Fig. 23) shows the commencement of a case where separation the width of a tooth (one having been recklessly extracted) is required. And in the next picture (Fig. 24) we see how well this has been accomplished. Unfortunately, time only permits of one example of each of a few classes of cases out of a great many. The next figure shows beautifully the fit of these crowns and the depth of a pyorrhœa pocket. The radiograph shows a perforation in the wall of the root of the first bicuspid through which cement has been forced into the tissue producing the suppuration and absorption, supposed to be a pyorrhea pocket. In this next picture (Fig. 26) we have an example of the service of the X-rays in determining the location of third molars. This one is not erupted at all, and lies at just right angles to its proper position as shown by the second molar. It would certainly be a difficult one to extract if you did not know its position."

"There is no field of application in which the X-rays will bless so large a number of mankind as in dentistry.

"The serious lesions and deformities of the teeth and oral cavity and adjacent parts are usually deep seated and their source and even location frequently entirely obscure. For example, what is the cause of this chronic empyema of the antrum? The lady is about seventy and the case has had skilful treatment for a couple of years. You see quickly the cause in this lantern-slide. It is a piece of a root partly perforating the antrum and which was buried deeply under the soft tissues. The X-rays have a much wider range of application in antrum troubles than has been recognized. This next case is of special interest because a malpractice suit was brought against a dentist claiming that in extracting the badly decayed roots of a molar tooth the operator forced one of them through into the antrum causing an acute empyema. This skiagraph shows clearly the antrum, but there is no root in it. This next slide, however, shows clearly the cause of the trouble which is the imperfect root-filling in the bicuspid. As you see, the chamber from which the pulp of the tooth has been removed has not been filled to the apex of the root. This almost invariably develops an abscess, and which in this case, as frequently occurs, has broken into the antrum. All the surgeons in the audience know the necessity of draining the antrum if possible from its most dependent or lowest point. But how can this be determined clinically, for the lowest point has not a universal or definite position? For example, in this case (Fig. 4) the lowest part of the floor of the antrum is between the first and second molars, but there is an anterior chamber or department separated by a high partition, the lowest part of which is over the first bicuspid. Observe how the roots of the molars penetrate the antrum and hence how easy for an



abscess at the apices of these roots to drain into it. In these cases the dense plate of bone forming the floors of the antrum is carried up over the apices of the roots, as, for example, this handkerchief when placed over this pencil forming a cone which in case of an abscess of this root draining into the antrum would probably be perforated at its apex. Suppose this first molar to be extracted to drain the antrum, it would remain full of fluid to the level of the apex of this cone, while a perforation into the antrum through its buccal wall between the roots of the first and second molar would produce the desired result and save a valuable tooth. And right here I must protest against the common practice of sacrificing valuable teeth for this purpose. It is not necessary, for the above operation is much better. This particular case was skiagraphed to determine the location of a piece of a needle which had been broken by the patient in the tooth and it was thought to have been forced through the apex into the tissue as it could not be felt inside the tooth. The skiagraph shows it plainly within the tooth.

"The next (Fig. 6) shows another case of obscure antrum trouble which evidently comes from a putrescent root-canal and abscess of the bicuspid. Notice how low the floor of the antrum is at its lowest part. These are only a few examples of antrum complications. Frequently the antrum becomes enlarged in a particular direction by the suppuration, and by skiagraphing both sides at the same angles and extent of the absorption can be determined. By this means the exact location and boundaries of an abscess in the process resulting from putrescent pulps can be determined and after they are very obscure even though producing great disturbance as in this case. (Fig. 7.) The patient had suffered for about three months from an obscure neuralgia and an examination of the teeth by different dentists revealed nothing abnormal. Several skiagraphs were taken of the teeth on the side affected and this blind abscess was found on the first inferior left bicuspid, which, when treated, entirely and permanently cured the neuralgia.

"One of the most difficult operations is to make an artificial fistula to drain a small blind abscess at the apex of the root. The skiagraph is of great assistance not only in locating the abscess, but also in showing whether you have struck it. This is shown by placing a lead-wire in the fistula and skiagraphing. In this slide the lead-wire in the picture marked 367 shows that the first attempt failed. The other picture shows that a second attempt was successful.

"In orthodontia, which is the correcting of the positions of the teeth or correcting of the features by changing the positions of the teeth, the X-rays are of great value to determine the *positions of the roots*. For example, it is desirable to move all the upper anterior teeth and the bone around them forward to correct a depression of the upper lip. The difficulty is to carry the roots *en masse* and not to simply push the crowns apart. This case (Fig. 21) shows the

position of roots at starting, and the view to the right shows the roots successfully carried apart without tipping the teeth.

"You doubtless all know of the difficulties and complications attending the erupting of the third molars, or wisdom teeth so called. This skiagraph (Fig. 22) shows the position of a typical impacted one, which was entirely hidden in the flesh and bone, not having erupted yet and producing very serious trouble. You will see the mechanical difficulty of extracting it, since it is engaged or locked against the second molar. The dentist sending the case, after seeing the skiagraph, operated by extracting the second molar first, and then the third, and then replacing the second molar after removing its pulp and filling its roots. Result excellent. The next shows a case with an external fistula on the ramus of the jaw, diagnosed by different surgeons as coming from an impacted third molar, and was operated on accordingly for its removal, but unsuccessfully. The skiagraph was then secured, which shows that not only the third molar has never formed, but an abscess at the root of the second molar which has a putrescent pulp, and which proves to be the cause of the whole trouble. There is no difficulty whatever in locating unerupted teeth by means of rays. For example, this patient, a lady over thirty, presented without either permanent cuspids, and the bony process was receded, making it seem quite probable that they had never formed, but they are both clearly shown in Fig. 24 just beneath the surface, and will be speedily regulated to their proper position.

"These lantern slides, unfortunately, do not show the excellent detail, either of the original negatives or of prints made from them. You may have observed how much more faithfully the teeth are portrayed in fine dental negatives than in skiagraphs taken of the whole head, for in the latter case they are duplicated and blurred by the shadows of the teeth of both sides of the arch falling together. The detail necessary to bring out an abscess, for example, could not be secured in that way.

"This next slide shows the condition of a girl at fourteen who has retained all the second deciduous molars. Why have the second bicuspid not erupted? And will they ever? are questions requiring to be answered, and could only be answered heretofore by a destructive operation. The skiagraphs reveal a strange condition. The second bicuspid are forming in the superior arch but not in the inferior. Of those above the roots are just beginning to form, though these teeth have already caused the absorption of the roots of the deciduous molars. While in the inferior arch no bicuspid have formed, there is present on the left side the formative organ, and in position, and it may yet perform its function.

"In Fig. 3 you see the location of a missing bicuspid. Remember the soft tissues are not shown in the picture, but only the teeth and bone. Clinically the condition suggested that the missing bicuspid had not formed. You see it clearly inlocked between the first



molar and the first bicuspid. You see also the developed crown of the second molar still without roots, and the developing crown of the third molar.

"Sometimes teeth wander far out of their proper position. Fig. 4 shows a permanent cuspid in the floor of the nares and in the posterior part of the hard palate, with its cusp just in the median line. The patient is about twenty years of age. It also shows a small supernumerary just inside and between the central incisors.

"Fig. 5 is even more remarkable, for it shows a fully developed permanent lateral root on which no crown has formed (a), and a fully developed central crown on which no root has developed (b). In this case the right permanent central and the left cuspid are nearly touching. The patient is a girl of fourteen years. The left central and lateral are missing, and there is to be seen between the right central and left cuspid what the mother remembers to be a temporary tooth. The skiagraph shows this supposed temporary tooth to be a crownless lateral with root perfectly formed, and also shows the rootless crown of the missing central with its incisive edge engaged against the root of the right central. This patient is of necessity quite disfigured, but the information suggests the proper course for the best correction of the error. This condition is the result of a bad fall when a baby.

"Fig. 8 shows a remarkable condition. The patient had suffered from a dead pulp in the left central, presumably caused by percussion in an argument about a year previous. After treatment the canal could not be closed without extreme discomfort and the tissue at the apex of the root seemed to be abnormally sensitive. The dentist in charge brought the patient for a skiagraph, which shows a fully developed cuspid tooth lying against the root of the central. It has caused a complete absorption of the upper third of the root of the lateral. The patient had a gold crown on the left cuspid, and he said he was sure it was on the permanent cuspid. The root of the deciduous cuspid, which proves to be the tooth crowned, is extensively absorbed on its mesial side. A piece of broach was placed in the canal of the central for skiagraphing.

"Fig. 9 shows the cast (c) of a girl's inferior jaw at fourteen in which no teeth have erupted back of the first bicuspid since the extraction of the first permanent molar, which was done by force when the patient was only six years of age, and was attended with great struggling, so I am told. The next view (a) is a skiagraph of the condition, and shows the position of the second bicuspid and second molar. The second bicuspid is lying on its side in the bone, about one inch back of its proper position, and the second molar is in proper position back of it. The treatment for correction is quickly suggested, and accordingly I have placed a rigid anchorage appliance on the anterior teeth, and have, after anæsthetizing and incising the gum tissue, inserted a tapped screw-post into the displaced second bicuspid. Fig. 10 shows work (a) in moving teeth bodily where the

anterior teeth had to be extruded to correct an intruded bite. It also shows (b) that the structure of the new bone is identical with that elsewhere. This case also demonstrates beautifully by comparison the improvement in skiagraphing when the penetration of the rays is properly adapted to the condition. Fig. 11 demonstrates the value of the rays for locating teeth that are supposed not to have formed. The missing permanent cuspid is clearly seen (a) inlocked in the process. The next view (b) shows this same permanent cuspid regulated to its proper position and retained with platinum wire. This patient is a young lady about eighteen, and on account of the permanent laterals never having formed, this correction is of very great value to her, for her features have been very greatly improved by her dentist since he secured this information.

"Fig. 12 (a and b) shows how much nature had corrected the position of a locked bicuspid in sixty days after it had been released by separating the teeth that are locking it. Test skiagraphs had first been made three months apart to ascertain whether Nature would make any progress in correcting it unaided, and it was found that she would not. This case is of special value because the patient suffered from a badly intruded upper bite partly caused by this condition, only one bicuspid having formed.

"When a case presents with symptoms of a pericemental inflammation and the history is uncertain, as it usually is, the ideal procedure for both the patient and dentist is to first skiagraph the condition and find out the location and extent of the lesion and its cause. Then he can go directly to the trouble with a minimum of time and effort and treat the condition consistently and intelligently. He can take the skiagraph and develop the piece of bromide paper put in with the film all within one or two minutes. Fig. 14 shows two such cases. The first (a) shows the location of the lesion which is causing the neuralgia to be about the apex of the second bicuspid, and its cause is clearly evident, viz., that the root has only been filled about half way to the apex. This tooth did not respond abnormally to percussion. The second picture (b) shows a similar case, and the trouble is about the apex of the mesial root of the first molars, which root is not properly filled to the apex, and the root is a little absorbed. This condition of absorption of the apex obtains in almost all chronic abscesses whether blind or not, and, in my judgment, can usually be best treated by root amputation without extraction.

"We will now turn our attention to the dentists' graveyard, root-canal fillings, where so many cover up defective, careless work, trusting it will never come to light, and often reminding the patient that when this tooth gives trouble again it will have to be extracted. Humanity should thank God for a new light that will go into these dark places and show up what is often criminally careless or wilfully bad work in filling roots. True, it is often impossible to properly fill roots, but if all were as well filled as possible, those imperfectly filled would be only those with so small a canal or so little of it unfilled



that the woes of humanity from this source would be infinitely less than they are. Figs. 17 and 18 show collections of good and bad, mostly the latter, however. *When skiagraphing comes to be used generally even a little in dentistry there will be a great improvement in the work of filling root-canals.* Fig. 25 gives an example of the use of the rays in opening through a filling or root-filling to an unfilled or partially filled root-canal. The first view (a) shows this case as presented with a blind abscess at the apex and a gold filling. The root-filling was done twenty years ago. You all know it is like trying to thread a needle at arm's-length in the dark to drill straight through a hard substance to an open canal in the root. Having the skiagraph before me I could tell by measurement when I had gone far enough, but could not tell the exact direction. To ascertain the relation of my drill to the canal two skiagraphs were taken at different angles with the drill in place, and were developed at once. As you see (b and c) my drill was only out of line about the width of the drill mesially, as seen by the centre view, but twice that distance lingually. It only took a few moments to get this information, and, after getting it, I was able to go as directly and quickly to the unfilled pulp-canal as if I could see it. Fig. 26 shows the use of the rays in a branch of dental surgery, viz., root amputation. The first view (a) shows the condition before operating. There was a large abscess involving both roots. This had been skilfully treated, but could not be cured by ordinary means, because of the diseased condition of the roots of both teeth, which were accordingly amputated without extraction. The second view (b) shows them after amputation, and the third view (c) shows the extent to which Nature has filled in this abscess cavity with new bone in thirty days. Fig. 27 (a, b, and c) shows the use of the rays in reaching an abscess through the root where the canal is too small to find. I drilled in the right direction as far as I knew I was safe, and put in a piece of broach and skiagraphed in two directions, as in Fig. 25. In this way I was able to drill the whole length of the tooth in safety, and, as you see by the final test, went straight through the apex and not through the side, as I would have been most certain to do without the help of the rays. Fig. 28 shows a case of root implantation less than three years after the operation. The root had been crowned with a logan. By comparing the density of this root with the others you will observe that the lime-salts have been almost entirely absorbed from it, which accounts for its lack of rigidity. Nature evidently considers it as an irritant and is trying to absorb it." (PRICE.)

Another dentist reports:

"Both of the following patients suffered with neuralgia. In the first case the radiograph gave a negative result, which was, however, of value because it demonstrated that the pains were not of dental origin. The teeth were all perfect and unquestionably

in a healthy condition, and it had been suspected that there might be an impacted wisdom tooth. The picture disposed of this theory. In the second case the neuralgia was equally severe and obscure. A skiagraph was made and disclosed the presence of pulp nodule in the root of the lateral incisor, the upper half of the canal showing clear, and thus indicating the presence of live soft tissue only. The canal of the cuspid is shown to be clear, while a root-filling in the molar shows a dark shadow. The pulp of this tooth being removed the pain disappeared.

"Without the picture there would have been no more reason for opening the lateral incisor than for so treating either of the adjacent teeth. There are conditions in dentistry that may be positively diagnosed by use of the X-ray which could not be known by other means, except by sacrificing the teeth." (STEPHENS.)

Also another:

"With us it is a very common thing for all abnormalities that present themselves to be immediately settled by a skiagraph. The nervousness of the patient from a long sitting has practically been overcome, in that with ordinary plates the exposures have been diminished to only one or one and a half minutes. I believe with the emulsion that is put upon the isochromatic plate and the introduction of a proper screen, we could get better pictures." (VAN WOERT.)

**Position of Film and Tube.**—An English dentist, speaking to the Odontological Society, remarked as follows:

"The anatomy of the mouth, more particularly in the relations of the roots of every individual tooth to the inner surface of maxilla or mandible, requires a good deal of attention in order to be able to place the film so as to catch the shadow of the roots under examination without superposing on that shadow that of a neighboring root. The curvature of the palatine surface of the maxilla, where the alveolus rounds off into the hard palate is very difficult to negotiate, and usually results in a compromise; viz.: if the general curvature of the film when moulded to the curve of the alveolus, be roughly estimated as making an angle of forty-five degrees with the axis of the root, it will be necessary to pass the rays through the teeth at an angle of forty-five degrees in order to maintain a perpendicular direction. The amount of distortion obtained in large work on a bent film and with slanting rays would obviously be very considerable, but in dental work, when the skiagraph is made of so small an object as a single tooth, a skilled arrangement of the film and tube reduces this difficulty to practically nothing. A clamp to hold the film steady was once considered desirable, but *no mechanical clamp answers the purpose so well as the finger of a skilled and steady assistant holding the film against the maxilla or mandible, while with the other hand making counter-pressure outside.* The head of



the patient is best fixed for exposure in the ordinary head-rest of a dental chair. Owing to the short exposures and the character of the work, it is perfectly safe to bring the tube to within ten inches of the plate, and this distance is recommended by some workers. Others employ fifteen inches."

While nearly all dental examinations use the radiograph on account of its superior adaptability to the work, yet sometimes a preliminary observation with a fluoroscope may be desirable. The modified fluoroscope designed for use within the buccal-cavity is an aluminum tube, containing at the opposite end a small mirror inclined at such an angle as to reflect the shadow from a miniature fluorescent screen in the wall of the tube to the examiner's eye. In the course of time improvements in the use of the dental fluoroscope may make it of greater service than it has so far been considered. Its limitations are, however, obvious.

## CHAPTER XXXIV

### X-RAY DIAGNOSIS IN DISEASES OF THE CHEST

Eye-Training for Pulmonary Fluoroscopy. STUDY OF DIAGNOSTIC FACTORS. PLAN OF X-RAY EXAMINATION OF THORAX. COMPARISON OF FLUOROSCOPY WITH PHYSICAL METHODS. DETERMINATIVE TESTS. STUDIES IN THE ALPHABET OF X-RAY READINGS. DIAGNOSIS OF PULMONARY TUBERCULOSIS. DETECTION OF FIRST STAGE OF PHTHISIS. DIAGNOSIS OF PUS. FUNCTION OF REPEATED EXAMINATIONS. DIAGNOSIS OF DISEASES OF THE HEART AND AORTA. HEART REFLEX. CHRONIC PERICARDITIS. SLOW PULSE. ANEURISM.

**Eye-Training for Pulmonary Fluoroscopy.**—So important is the subject of pulmonary diagnosis that too much can hardly be done to put the observations of different workers before the practitioner. *Comparison* of teachings will perfect individual skill, and repetition of even familiar facts will often bring out some detail that was missed before. In fluoroscopic examinations of the chest the danger of dermatitis is absolutely *nil*. No special precautions are required. Healthy lungs are translucent. Normal shadows must be studied in the healthy, and compared in the young, middle aged, and old of both sexes—and in persons of different degrees of muscular development from obesity to emaciation. Shadows of the scapulæ, the anterior axillary fold, and the nipple, when seen, can be distinguished from deep tissues by having the patient move the arms. While the very earliest deposits of tubercle may not yield any appreciable shadows, yet all that can be said on this subject of early recognition must stand or fall according to the personal equation of the observer. The *eye-training* needed for diagnostic work in suspected incipency of phthisis is not the possession of the physician *per se*. *Practice* alone can cultivate it, and till it is cultivated it does not exist.

Advanced tuberculous changes cast definite shadows, and a few men of great experience have also been able to assert a diagnosis from the radiograph before any physical signs appeared. In some suspected early cases, moreover, when experts have failed to find evidence on the screen, time has shown that no disease appeared later.



When ordinary diagnosis has detected disease at one apex the screen has sometimes found it to be bilateral also. The more advanced the disease the darker the shadow, especially when caseation is in progress. Cavities are indicated by light areas in the midst of dense shadows. Fibroid changes and adhesions only create shadows after they have attained a definite density, and these shadows differ considerably from those cast by tubercle. Emphysema is indicated by exceptional transparency of the affected part of the lung, as air is more easily penetrated than any tissues. In early dry pleurisy only a very faint shadow can be detected. Serous effusion causes a dim blurring of the rib shadows but does not hide them, and the upper margin of the fluid often shows a clear line of demarcation. Study the differentiation of these degrees of shade.

Take a wooden sample-bottle such as are used for mailing drugs and half fill it with water. Hold it in front of the fluoroscope and turn it various ways and tilt and shake it. Profitable study of such shadows as are caused by water in the pleural cavities can be improved in this way. The water has a shadow of its own. Purulent effusion causes a darker shadow. If sufficient in quantity it may cast a very dark shadow. The same study of it can be made as with water. Secure a tube of pus removed from a case of empyema and study it with the screen. It will present nearly the opacity of bone. Blood and serum should be put to the same tests, and they make lighter shadows. This kind of study will rapidly develop diagnostic confidence and skill.

Abscesses, like caseating nodules, cast very dark shadows, and even through thick tissues, such as the kidney, caseous tuberculous nodules have been clearly discerned. Enlarged and caseous glands cast recognizable shadows. In the chest the detection of morbid growths and aneurisms is quite accurate with the X-rays. To study and arrive at diagnostic expertness in these fields of examination the physician can artificially create most of the densities and keep at hand a series of comparative tests which will rapidly familiarize him with clinical conditions, and further practice will develop the expert. These are some of the rudimentary generalities of the subject of thoracic examinations. We will now study certain specific diagnostic factors in fluoroscopy of the respiratory organs. Their importance is great.

"The diagnostic factors of a fluoroscopic examination of the thorax are *light, shadow, and motion*. Upon these three rests the most elaborate examination by X-rays." But when we apply these simple factors to differential diagnosis we need not only the physician's

knowledge of anatomy and disease, but must also have ascertained by other methods of examination an idea of the probabilities in the case. X-ray shadows are not like maps with names engraved on them to identify lesions, but with a medical knowledge of what ought to produce a certain appearance we may then say that the appearance (when seen) has this probable cause behind it. Exclusion furnishes the last refinement to the final diagnosis. Speaking of the fluoroscopic chest-picture Crane has said:

"Shadows of varying density may appear, abnormally clear areas may develop, the heart or diaphragm line may become displaced, obscure or invisible, and the motion of the diaphragm may be restricted or reduced to zero. These appearances must be interpreted in any given case to mean infiltration, consolidation, cavity, effusion, infarction, etc.; and these conditions must be summed up with medical skill and further interpreted to mean tuberculosis, pneumonia, pleurisy, oedema, etc. The diagnostic resources which lie in the fingers and ears of the practitioner command our respect, but such is the supremacy of the *eye*, and such the importance of things seen, that even after a careful physical examination the fluoroscopic image comes like a revelation to the observer."

With these facts in mind we will now consider how practised clinicians apply them.

**Plan of X-Ray Examination.**—To save time and avoid overlooking points adopt a routine system. First make the usual physical examination. Examine the sputum if there is any. Lastly, with outer clothing removed, make the fluoroscopic inspection. If any condition is discovered which is of interest to record, or is too obscure for the fluoroscope and requires a finer definition, make a radiograph. Full technics for the most rapid and convenient fluoroscopy of the chest with intercurrent radiography are taught in Chapter XV. Refer to them and proceed accordingly. The specialist doing routine work of this kind is advised to keep his tube connected up in a tall upright case, which preserves it from dust and accident, while always ready for this particular use by simply opening the case door. See Instruction Plates of the uses of the Skiameter, Nos. 146, 147.

Inspect the upper, middle, and lower thirds of the lungs, both front and back. Compare like parts on opposite sides. Compare different areas of the same side. Note the heart shadow and the diaphragm line. In a doubtful case compare the view with that of a healthy subject. Frequently also refresh the training of the eye by studying the chest in health.

The difference between the front and back views is due to get-



ting different structures in closest relation to the screen. The most distant shadows are diffused and diminished. The thin front ribs cast but little shadow, and when the back ribs are distant from the screen a fairly clear view of the area of the lungs is obtained. The dark line of the spine cannot be evaded, but the scapulæ can be got out of the way by extending the arms over the head. If in a rare case the female breast hinders the contact of the screen have the patient draw it as much aside as possible. When the back is against the screen the thin front ribs and sternum are distant, and thus cast only a diminished shadow. This may give the best view of some diseased areas. After a little practice lay out a systematic plan of examining the different areas in regular turn and then adhere to it.

**Comparison of Fluoroscopy with Physical Methods.**—"When the X-ray examination is preceded by the physical examination an opportunity is given to compare and supplement the results of one method by the other. The *end*-results must agree if the phenomena observed are correctly interpreted, but the information elicited by inspection, palpation, percussion, and auscultation is not in each case *coextensive* with the information gained by the fluoroscope, skiameter, and skia-graph.

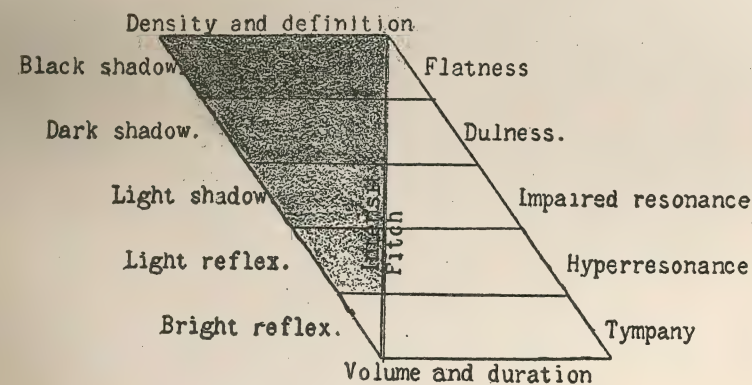
"By *palpation* we may feel the rhonchi, the friction fremitus, and the vocal fremitus. The rhonchi and friction fremitus denote conditions which give no sign on the fluoroscope. The vocal fremitus is increased over consolidated areas and decreased over emphysematous areas, and in this it agrees exactly with fluoroscopy. If, however, we draw the conclusion that whenever the vocal fremitus is increased we should find an increased density in the fluoroscopic shadow and vice versa, we will be disappointed. In pleuritic effusions we find the vocal fremitus decreased or absent, but we find the fluoroscopic shadow dense and unmistakable. The same is true of pleuritic thickenings, of filled cavities, and of consolidations with occlusion of the large bronchi. Moreover, the vocal fremitus is increased over dense-walled cavities which would give a ringed area of light-reflex upon the fluoroscopic screen. In these states it could be said that the results of palpation are not parallel with those of the X-ray, but the narrow limits of palpation must be kept in mind and only its positive data considered.

"As we reduce fractions to a common denominator, we may reduce light and shadow to the common terms *increased transparency* and *decreased transparency*. Either *increased* or *decreased* transparency may differ in intensity, position, form, and extent. Motion may likewise differ in character and extent and in the method by which it is elicited. In those pulmonary diseases in which there is an increased amount of air in the lungs on one or both sides, we would expect to find with the fluoroscope an increased transparency in one

or both lungs. This is discovered to be a fact in asthma and emphysema. In those diseases in which there is a diminished quantity of air in the lungs we would expect to find a diminished transparency to the X-ray. This we find to be true in congestion, pneumonia, tuberculosis, and many other diseases.

"Focal diseases, such as abscesses, infarctions, and tumors would be expected to cast shadows proportioned to their size and density. It is the density of a focus-lesion which determines the density of its shadow. There must be *more substance* in the path of the ray if it *diminishes* the *transparency*. Lack of air in the lungs would not alone account for the decreased transparency during expiration. The settling together of the lung-tissue in expiration contributes something to lung-density, but there must also be an *increased quantity of blood and lymph* in the lungs to account for all the change. Likewise in any point of inflammation there is an increased blood-supply. The tissues may be soaked with serum and infiltrated with leucocytes. The air-cells even may be filled with exudate, and thus the density of a part is increased and its transparency to X-rays decreased.

"Between *percussion* and the fluoroscope the comparison is more satisfactory. The same factors which determine the X-ray shadows also determine the character of the percussion-note. The results of percussion and skiascopy must agree, allowing for the personal equation and for the superior delicacy of one or the other in different hands. In my experience they *do* agree, except that skiascopy is the more delicate and more precise method. We may express the relation of percussion of X-ray shadows by adding a diagram.



This figure aims to convey an idea of the comparative relations between X-ray shadings and sound-notes. The internal conditions producing both evidences to the eye and ear can be best pictured to the mind after the study of shadow-values as taught in this work.

"The field of *auscultation* is larger in some directions than that of pulmonary skiascopy. Affections of the bronchial tubes denoted by *râles*, and inflammation of the pleura denoted by friction-sounds,



are beyond the province of the X-rays. Auscultation is a most delicate method of examining the thorax, and the data which may be elicited are numerous. But their interpretation is often a matter of confusion or doubt even to a professor. Changes in the vesicular breathing; bronchial breathing; amphoric breathing; broncho-vesicular breathing; râles, large, small, dry, moist, sonorous, sibilant, crepitant, sub-crepitant, mucous, or bubbling; friction-sounds; bell-tympany; succussion; metallic tinkling; bronchophony; pectoriloquy, egophony, Wintrich's change of sound; William's tracheal tone; Gerhard's change of sound; Fredreich's change of sound; and Leitz's metamorphosing; all of these suggest the resources and difficulties of auscultation.

"Skiascopy gives more simple and direct data. The apparatus which generates the Roentgen rays may be complex, but there is nothing unduly complicated about shadows on the fluoroscope screen. The shadow of a bottle partly full of water gives more simple and more direct evidence of its existence and character than do the sounds which may be elicited from it. The margin for possible error is wider for the stethoscope than for the fluoroscope. But when the signs are correctly elicited, correctly recognized, and correctly interpreted, *the results of auscultation must agree with those of skiascopy.*

"Skiascopy is not compared with *inspection* because it is itself inspection. It is an extension of our facilities of sight. It is therefore *a part of the physical examination and not a method to supplant it.* Although it bears comparison with the combined results of palpation, percussion and auscultation, it should not be considered as a rival, but as an *ally.* By Roentgen's discovery *inspection* is now raised to the first rank of our diagnostic resources. We base a diagnosis not upon the results of one, but upon all the lines of physical examination. Auscultation is not alone relied upon. For the same reasons *skiascopy should be interpreted in conjunction with the physical signs and the clinical symptoms.*" (CRANE.)

We will next study the pulmonary findings of the radiograph in a most valuable series of clinical tests of late date.

**Determinative Tests.**—Very instructive analytical tests were made by Walsham\* to determine causes of pulmonary appearances in the radiograph and the relation of certain shadows to diagnosis. His observations were presented to the Congress on Tuberculosis, London, July 22 and 26, 1901, and are so valuable that every physician should read them. We therefore supply the essential text.

"Since Professor Roentgen made known his brilliant discovery, now some five years ago, I have been at work on the use of the X-rays in the diagnosis of pulmonary tuberculosis. I propose bringing be-

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fore you this morning very briefly some of the results attained. The questions I attempted to answer, if possible, were the following:

"1. Can X-rays show tubercle in the lung?

"2. If so, at what stage of their development?

"3. Can X-rays detect tubercle in the lung earlier than diagnostic methods already at our disposal?

"Now, obviously the first step to be taken in the attempt to answer the first question was to obtain a radiograph of the normal chest, to study its shadows, and endeavor to differentiate between the shadows cast by structures outside the thorax from those cast by its contained organs.

"The next step was to take a radiograph of an undoubted case of pulmonary tuberculosis and compare the one with the other.

"I will now, first of all, throw on the screen a picture of a normal chest. We see at once that the pulmonary image in health is quite transparent from apex to base, with the exception of a few ill-defined shadowy lines to the right of the heart shadow. These cardiac lines are seen (more or less pronounced) in all skiagrams of the healthy chest, and must therefore be considered normal. Now, on what do they depend? Are they cast by the lower division of the longer bronchi? I think not. If we look at a picture of a normal lung skiagraphed outside the chest we see that only the primary division of the bronchi are seen, and, in addition to this, these cardiac lines are too low to be caused by the bronchi.

"I have endeavored to clear up this point in the following way: A skiagram was taken of a dead body on the post-mortem table. I then removed the sternum, opened the pericardium, removed the heart, replaced the sternum and integuments, and took a second radiograph. The lines still appeared in the negative. I then opened the chest, removed the lungs, replaced the sternum and integuments, and again radiographed the body. The effect is shown you on the screen. You see that these cardiac lines still remain and are caused no doubt *by the junction of the pericardium with the pleuræ.* They are much more distinct in the dead body, of course, as they are not then in constant movement with the contraction and expansion of the heart as they are in a living person.

"The next point you will observe is that *the shadows of the scapulae are absent.* Their shadows only complicate pulmonary examinations and are better removed. This can be done in the following way: *The patient lies in the prone position on the plate, the arms being extended and hanging over the end of the couch. In this position the scapulae are turned edgewise, so to speak, and their shadows are removed from the skiagram.*

"The next shadow to call to your attention is one well shown in our next lantern-slide, and is usually seen in the more muscular subjects. It is, as you see, somewhat triangular in shape, and extends upward and outward toward the axillæ. When viewed in *stereoscopic radiographs* these shadows are seen to be *outside* the



chest and are caused by the anterior axillary folds of muscle. They are only seen, I think, when the patient is radiographed in the prone position with extended arms, this position naturally rendering the axillary folds thicker.

"A word as to the *diaphragm*: it is not so much the *shadow* of the diaphragm in the negative that is important in pulmonary diagnosis as its *movements with respiration* as seen with the fluoroscope. Now, if the diaphragm be watched with the fluoroscope we see that it does *not*, as physiologists tell us, become flatter with inspiration. *Its curve is always maintained unaltered*. It plunges up and down piston-wise, and this brings us to a point of great importance in the diagnosis of pulmonary tubercle. *The movement of the diaphragm on the affected side is much less than on the non-affected or less affected side, and this when the disease is limited to one apex*. Why this should be so may be hard to explain, but the fact remains.

"I will now throw on the screen a picture of a case of pneumothorax, showing the depression of the diaphragm by the increased pressure in the pleural cavity. If you will look again for a moment at the picture now on the screen you will see that the healthy chest in the living person is as clear as that of the dead body with the thoracic viscera removed, showing *that any abnormal shadow seen in the skiagram is due to some pulmonary change*, the muscles and integuments of the thorax being transparent to the rays.

"There is one other shadow I will mention. We occasionally see an ill-defined curved shadow in women with large mammary glands. Here the stereoscopic method again shows these shadows to be outside the thorax and therefore not to be confused with shadows produced by pathological changes in the lungs.

"I will now throw on the screen a well-developed case of pulmonary tuberculosis. You see at once there is a marked difference. The clear pulmonary image is obscured by flocculent shadow, punctate in parts. Now on what do these shadows depend? Are they due to tubercular consolidation or to patches of congestion of caseation or pleural adhesions or what? I have endeavored to answer these questions in the following way. On the screen before you is the skiagram of a tuberculous lung; nearly the whole of the upper lobe was caseous and breaking down. So we see that caseation throws a very dense shadow. The shadow, lower down, caused by gray and yellow tubercle, is nothing like so dense; still, as it might be said that some of this shadow is due to blood congestion round the tubercular consolidation, I performed the following experiment: The lungs from a case of pulmonary tuberculosis were taken; one was soaked in water for some hours to break up the blood-corpuscles, the vessels washed out until the water came away colorless. Both lungs were then skiagraphed, and I think you will agree with me that there is little or no difference between them.

"Again, it has been asserted that the blood next to the bones is



PLATE 145.—This Instruction Plate shows the Author's Examining Frame turned sideways and adjusted to an inspection of the chest, either back or front positions being equally engaged in the axis of the rays, which the frame holds fixed while the patient is shifted to bring successive fields and areas into the constant line of non-distortion. Letters A A in the intersecting angle of front and rear markers indicate the axis of the rays from the anode to the fluoroscopic screen. Simply level the frame, insert the patient, clamp on the screen and light up the tube and inspect the parts as taught. The photograph shows the patient's right arm thrown over the frame to get the shadow of the scapula out of the way, and the operator just ready to place the fluoroscope and begin the examination. The position of the camera failed to show the anode focus in exact line with the A A of the markers, but the plate suffices to teach the method.





PLATE 146.—Measuring Pulmonary Shadows by the Skiameter. Frontal position. Level the tube, hold the skiameter in the right hand against the back with the screen in front as shown in the Instruction Plate. The text makes the method clear. This plate also shows the tube in a "closet" holder which shuts when not in use and protects the tube from dust and breakage. In the corner is also a mounted open screen of large size, which is employed as taught in the next plate.



PLATE 147.—Measuring Pulmonary Shadows by the Skiameter. Dorsal position. Hold the Skiameter over successive areas of the chest while observing the shadows from behind with a large mounted open screen instead of the fluoroscope. Cut does not show the light-screen to hide the tube or the use of the cloth which may be thrown over the head and around the field of examination to create a dark chamber for the eyes. Both plates teaching the use of the Skiameter were photographed especially for this work by Dr. A. W. Crane, of Kalamazoo.





PLATE 148.—Tuberculosis of left lung showing darkened areas. Heart shadow undefined. Normal transparency of right lung shows it free from disease at time of radiographing the case. Examine this plate with mirror to reverse the picture.

the most opaque tissue of the body. With this assertion I cannot agree. Look, for instance, at the picture now on the screen. It represents a portion of a rib, a piece of muscle the same size, and a blood-clot. My eye can detect no difference between the muscle and the blood-clot—that is to say, clotted blood, which, by the bye, is more opaque than fluid blood, is no more opaque to the rays than muscle. Again I took the lung and kidney which contained tubercle from the same case, and radiographed them together. The tubercle in the kidneys is distinctly seen, down to the minutest miliary tubercle which could be detected by the naked eye. Again, look at these lungs from a case of acute miliary tuberculosis. They show the tubercle scattered through their substance clearly enough. Putting the above facts together, we may, I think, answer our first question by saying that the Roentgen rays *can show definitely tubercle in the lung*.

“I will now throw rapidly on the screen some cases of undoubted pulmonary tuberculosis more or less advanced. I now come to the question of the detection of cavities in the lung. That the X-rays can *detect with certainty a cavity in the lung* is now a *fact beyond question*. With reference to the size of a cavity, I would say that the rays *can diagnose a cavity much smaller than can be detected by auscultation*. The smallest I have yet met with is now on the screen before you. It is less than a small marble. The Roentgen rays are also of great use in judging the size of a cavity. Occasionally auscultation gives evidence of a cavity of large size, and we are surprised, on examining with X-rays, to find that the cavity is a small one. This must mean that the consolidation round a cavity must conduct the sounds produced in the cavity far beyond its limits. Furthermore, it not infrequently happens that auscultation diagnoses a cavity which the rays show has no existence.

“I will now pass on to the second question, viz., At what stage of development can the X-rays detect tubercle; and here I am afraid we must admit that the very earliest stage in the development of the tuberculous process cannot be detected by the X-rays, but this also applies to all our other methods of physical diagnosis. The first beginning of tubercle in the lung cannot be detected by this or by any other means at our disposal. There can be no doubt that the X-rays are able to pick out in shadow a *very small* tuberculous focus in the lung. I will give a few examples. The skiagram on the screen is from the chest of a man aged twenty-eight; he came to the outpatient room complaining of his digestion. On examining the chest there was nothing to be made out except perhaps a little weakening of the breath-sounds at the right apex. I examined this patient radiographically, and had no difficulty, as you see, in diagnosing a tuberculous process at the right apex. The next case is that of a woman aged thirty-four. In this instance there was a little prolongation of expiration, with some slight difference in the percussion note at the right apex. I was somewhat surprised, therefore, to find



sputum. If the patient is re-examined on the table, the cavity may then empty and become a large bright reflex, or it may nearly disappear, because the mass of sputum has come to lie in line with the empty space.

"If a faint reflex be observed without the presence of pulmonary shadows, it is probably due to a dilated tube in bronchiectasis. A dilated bronchus with consolidation could not be distinguished from a small cavity, unless a longitudinal form were to give a clew. A small pneumothorax, allowing a layer of air to surround the lung, would give a general light reflex, which would be indistinguishable from a true emphysema. In both cases the movements of the diaphragm would be restricted, its line low, and its form flattened. But an emphysema is bilateral, unless there is some disease of one side to produce a compensatory condition on the other. In the case of pneumothorax, the disease would be on the same side as the general light reflex. Hydropneumothorax or pyopneumothorax would give the same images as pneumothorax, except that we would have the dense shadows of effusions at the base. By changing the position of the patient, the relative position of the shadows and light reflexes would be changed. A light shadow may mean an infiltration, a congestion, and atelectasis, or a thickened pleura. Between a tuberculous infiltration, a simple focus of congestion and an atelectatic area, there is no shadow distinction. A thickening of the pleura may sometimes be differentiated from these three if the shadow be plainly visible, say from the front, and nearly or quite invisible from the back. But an infiltration or small infiltration laying close to one side would simulate this appearance. A dark shadow indicates a partial consolidation—a small tumor, an infarction, or a cirrhosis. In the case of œdema the dark shadow is general and has an even density. A general cirrhotic lung would give a less even shadow, and would be accompanied by a marked displacement of the heart. Other physical conditions easily differentiate these two.

"A focal cirrhosis and infarction and a small tumor, may give shadows of similar character, but a cirrhotic focus is most likely to be located in the apex, a tumor most likely near the hilum, and an infarction most likely in the periphery. A partial consolidation has very indefinite borders shading out into normal lung-tissue. A small filled cavity is associated with some consolidation, and will appear as a dark spot in the midst of the dark shadow.

"A black shadow may result from a consolidation, gangrene, large filled abscesses or cavities, large tumors, large hydatid cysts, and pleuritic effusion. The last is distinguished by lying at the base of the thoracic cavity, by obscuring the diaphragm line, by a more or less level upper border, and by being shifted when the patient's position is changed. The other conditions may not be separable by an X-ray examination, but their boundaries may be mapped out.

"The diaphragm cannot be disregarded in fluoroscopy of the lungs. Its visibility, position, form, and motion are functions of the

highest importance in estimating the extent and severity of pulmonary disability. It is the vital barometer of the lung, and they here give the first signs of coming clouds above. Its visibility depends upon the contrast which its heavy shadow makes with the thin shadow of the lung. It is a dome of muscle which rests upon the liver on the right, and is visible across the whole extent. On the left it rests upon the stomach and is visible across the outer half of the heart, the inner half being obstructed by the shadow of the heart. In forced inspiration, however, the diaphragm becomes also visible below the heart. The pericardial space between the heart and the diaphragm is formed in forced inspiration when the diaphragm pulls down the pericardial sac while the attachment at the base holds up the heart. The presence of the *pericardial space* may be taken as a positive sign that *no pericardial effusion exists*.

"The shadow line of the diaphragm becomes more distinct in forced inspiration because the lungs contain more air, and because the diaphragm, being flatter, interposes more tissue in the path of the rays. Conversely, the diaphragm lines become less distinct in forced expiration because the lungs contain less air, and also because the diaphragmatic dome, being more arched, interposes less tissues in the path of the rays. The diaphragm becomes very distinct when there is an emphysema or pneumothorax without effusion. But emphysema is either bilateral or else compensatory, and attended by disease on the opposite side. On the other hand, pneumothorax would show the shadows of a partially or wholly collapsed lung. The diaphragm may become indistinct in œdema, hypostatic congestion, partial consolidation of the lower lobes, or thickened pleura around the base. But in œdema there is a general shadow of an even density. In congestion, partial consolidation and thickened pleura at the base, the upper areas of the lung may be normal, but these three are not separable on physical grounds alone.

"The diaphragm becomes invisible when there is an effusion or a consolidation of the lower lobe. But with effusion the outline of the shadow may be easily shifted, and when the patient is put upon the examining table with the head and trunk tilted downward the diaphragm comes into view. If the entire lung is consolidated, or if the effusion reaches the apex, the conditions may not be distinguishable without the use of the hypodermic needle. The position of the diaphragm in health is variable. The mean in ordinary respiration is, for the right side, the lower border of the fifth rib; for the left side, the upper border of the sixth rib. *The left side is normally about one and one-half centimetres lower than the right.* In disease of one side this difference is exaggerated.

"If the right lung is affected by tuberculosis, the diaphragm on that side will be higher than usual, while on the left it will be lower than usual, on account of the compensatory changes. In emphysema the diaphragm lies very low, in cirrhosis very high. The position of the diaphragm largely determines the form. It is flat-



tened when low, and arched when high. In diaphragmatic hernia the form is irregular.

"It is the *motion* of the diaphragm with which we are chiefly concerned. We may recognize the range of movement in ordinary and in forced respiration. By marking the middle point in ordinary respiration, we may observe the upper and the lower half of a forced respiration. As a rule, in health the range of ordinary and forced respiration is slightly greater on the right side than on the left. *A restriction in the range of motion is a sign of some disablement.* It is most likely to mean tuberculosis, pneumonia, or pleurisy. But it may mean almost any affection of the lungs or mediastinum.

"In true emphysema and pneumothorax the respiratory movement is restricted in its upper half. In compensatory emphysema the respiratory movement is increased in both upper and lower half. This is important, because a compensatory emphysema on one side means an impairment of the lung on the opposite side. It may, however, in rare cases, be an old trouble from which the patient has recovered. A very marked restriction in the motion of the diaphragm or its immobilization is a grave sign. Pleurisy, especially diaphragmatic pleurisy, forms an apparent exception. However, if the patient be encouraged, the diaphragm can be moved, although pain is the result. It is a significant fact that nature so quickly *immobilizes a diseased lung.*

"*When in addition to the shadow-free lung, we find a natural movement of the diaphragm, we may feel assured that, even though tubercle-bacilli are present in the sputum, the lung is not yet affected. Such cases may be laryngeal or bronchial.*" (CRANE.)

**Diagnosis of Pulmonary Tuberculosis.**—The report presented by Bouchard and Claude to the Congress on Tuberculosis held in Paris is remarkably instructive.

"In this disease *at the outset* the lesions consist of new formations which constitute an obstacle to the penetration of air and a slight obstacle to the penetration of X-rays. At this stage the fluorescent screen will show at one apex, or both (sometimes at several places in the lungs), small spots, ill-defined at their circumference, or a slight mistiness veiling one apex. In other cases the appearance resembles a stippling of small shadows on a less dark ground. *Confluent pulmonary infiltrations* with a tendency to softening and ulceration give rise to almost complete opacity. These are darker in the case of lobar infiltrations, and lighter in the case of lobular infiltrations.

"*The intensity of the shadows is proportional to the interference with the penetration of air into the vesicles.* If the lesion forms a compact and considerable mass absolutely impenetrable by air the shadow shown on the screen is complete, but if there are a number of little nodules separated by parts still permeable by air, the general opacity is less intense, and on the dark ground there will be

seen still deeper shadows corresponding to points of complete caseation.

"*Cavities* appear on the screen as a *complete opacity* only (1) if they are filled with pus, or (2) if deeply seated and surrounded by pulmonary tissue stuffed with tubercle; or (3) when a layer of dense adhesions obstructs the passage of the rays. If the cavity is superficial, *empty*, and has a thin wall, it shows as a clear zone in contrast with surrounding parts of the lung which appear more deeply shaded. It is oval in shape, and the ribs in front of it are visible. When the cavity *fills up*, the clearness which marks its situation diminishes, and we see only a large shadow, rather less dense at one part than throughout its general extent.

"Every degree of variation is possible, but *the essential character in all forms of the shadow-picture of cavities is the presence of a very dark zone more or less circular in outline, surrounding a region relatively clear or altogether transparent, while the rest of the lung adjacent is in shadow.* It is the sharp contrast between these two elements of lesion-spots relatively clear *showing on a ground palpably dark*—a shadow shading off at the circumference, and sharply defined around the central clear zone—that is characteristic of a cavity.

"The *pneumonic confluent form of acute phthisis* reveals itself on the fluoroscope by complete opacity of the diseased part. This is explained by the fact that at these points the lung is no longer pervious to air.

"*Effusion at the base* is shown by a thick shadow which hides the diaphragm, and is lost below in the obscurity of the abdominal mass, and is limited above; a zone of shadow directed obliquely from above down from the axillary region to the vertebral column, or in the shape of a curve which is concave at the upper border. Examination at intervals of a few days will show the variations in the amount of effusion by variations in the extent and form of the shadow.

"An intense opacity with a generally rounded outline occupying the middle part of a lung, in which the upper and lower parts have retained almost their normal clearness, suggests an interlobar effusion. Here, again, the *variability of the shadows at different times* assists the diagnosis.

"Dense and extensive *adhesions of the pleura* manifest themselves by shadows which are less dark, but constant in their form. In such a case it is often impossible to distinguish the condition of parenchymatous lesions by fluoroscopic examination alone.

"*Pneumothorax* is characterized by an abnormal *transparency* of one side of the chest, which allows the light to pass through without any interference except over a small area on the affected side corresponding to the retracted lung. The heart and the vessels may be displaced. The curve of the diaphragm is lower than in health.

"In *hydropneumothorax* and *pyopneumothorax* the appearances vary according to the position of the patient. If he is lying down



the whole of the affected side is dark. If he is standing up, the upper part of the side is more transparent than in the normal state, and the lower is opaque.

"Even slight tuberculous changes in the pleura affect the mobility of the *diaphragm*. In general terms it may be said that in *pulmonary tuberculosis* there is a *diminution in the movements of ascent and descent of the diaphragm*. This change may be seen on one or both sides. The fluoroscope can also give important information as to the condition of the mediastinal glands in tuberculous patients.

"In acute or sub-acute *bronchitis*, the two sides of the chest show little or no departure from the normal state, and there is no change in the respiratory movements of the diaphragm—*negative signs* which may often be of importance in prognosis.

"In *pneumonia* there is complete opacity at the part corresponding to the lesion. This opacity, however, varies in its limits and intensity from day to day. The movements of the diaphragm are diminished on the affected side.

"*Non-tuberculous* broncho-pneumonic foci cause a slight opacity, but this becomes *less marked* on deep inspiration, while foci of pulmonary *sclerosis* do not become clearer on deep inspiration.

"In simple *emphysema* the *transparency is increased* by the increase of air present, and the ribs are less distinct.

"The emphysematous lung is larger than normal and extends into the pleural cul-de-sacs, so that the transparent surface corresponding to the organ extends more upward toward the mediastinum, and particularly more downward toward the abdomen. When the patient is examined at the back there is seen below the diaphragm a transparent surface of much greater extent than normal.

"*The use of the X-rays makes it possible in certain cases to discover commencing changes in the lungs at a period when other methods of clinical investigation are negative.* In other cases the fluoroscope defines the extent or reveals the importance of a lesion insufficiently disclosed by auscultation or percussion. It enables the practitioner to *exclude tuberculosis* in cases where symptoms and clinical signs puzzle the physician; while at the same time it often enables him to trace to their true cause general disturbances which clinical observation has failed to locate.

"Fluoroscopic examination is not merely the method of control, correcting or supplementing the ordinary methods, but it yields new information. By making visible the working of the respiratory apparatus it shows the functional value of one lung. It discloses the pleural adhesions, the pareses or ankyloses of the diaphragm, which limit expansion: *it makes the evolution of the disease visible to the eye.*"

In the report of Beclère before the Paris Congress on Tuberculosis the author held that for exact and complete diagnosis of tuberculosis lesions the examination should include a radiograph as well as the

fluoroscope. He described *X-ray diagnosis* in *latent, suspected, and declared* tuberculosis.

"In latent tuberculosis the patient has every appearance of perfect health and presents absolutely no physical sign or symptom of disease. The frequency of this condition is shown by the large number of soldiers who have died of various diseases in whom old unsuspected tuberculous foci have been found. In a series of experiments 124 men were examined, selected from among those in whom ordinary diagnostic methods excluded tuberculosis. Seventy-three of these cases gave negative results with the fluoroscope, but the remaining fifty-one revealed abnormalities of various kinds—lessened transparency of apices, enlargement of the bronchial glands, more or less marked opacity of the pleura, diminished movement of the diaphragm.

"The use of the X-rays also serves for the identification of tuberculous lesions which disguise themselves under the mask of anæmia, chlorosis, dyspepsia, and neurasthenia.

"In cases of suspected tuberculosis, if the disease attack the lungs suddenly, the fluoroscope shows chiefly a diminution in the clearness of the shadow at the apex, and pushing down of the diaphragm on the affected side. Tuberculosis may begin with an attack of diaphragmatic pleurisy, the symptoms of which are so slight that the only proof that the pleura is involved and that the case is not merely one of intercostal neuralgia is supplied by the X-rays, which show thickening, diffusion, and immobility of the diaphragmatic shadow. If the case is one of dry pleurisy, or 'stitch' in the side, but without any decisive physical sign, the fluoroscope shows superficial opacities quite close to the thoracic wall. In cases of effusion the condition of the apex in regard to transparency on the affected side must be carefully investigated. *Even a slight degree of opacity in the region of the apex is important in prognosis.* In declared tuberculosis the lesions are plainly shadowed on the screen. In such cases the X-rays are more valuable for prognosis than for diagnosis, since the diagnosis is already made. They will show when both apices are attacked, when ordinary clinical examination appears to warrant the conclusion that one is still sound, or when the lesions extend lower down than is disclosed by ordinary methods. X-rays are particularly useful for the detection of central lesions, which are apt to be overlooked on account of the depth at which they are situated."

**Detection of First Stage of Consumption.**—In discussing the question of an earlier diagnosis of tubercular disease of the lung by X-rays than by clinical methods, Immelmann states:

"To answer the question at the head of this paper we will consider at what stage of lung disease it has been possible to give an undisputed diagnosis with the methods in use hitherto. We cannot rely upon *percussion*; its results are often in no proportion to the gravity of the disease. It may not give any indication in very early



stages of the malady, nor even of small cavities imbedded in the air-holding tissues of the lungs. With *auscultation* it is not very different. No sound of respiration is *characteristic* of the phthisical process. We are in a position to give a definite diagnosis *by clinical methods* only *when* the tuberculous foci of disease disintegrate and open into the bronchi, and the possibility is offered of finding tubercle bacilli in the sputum. I have carried out the following experiments as clinical tests:

"1. Having examined eleven patients with the screen in whose sputum bacilli have been observed for the first time shortly before, in all of them I was able to decide that infiltration and disease-foci of the lungs showed as dark places in the air-containing lung-tissues.

"2. In eight patients suffering from lung catarrh but having no bacilli in the sputum, I observed that the apices of the lungs appeared less transparent than the normal. After three or four months four of these have bacilli in the sputum.

"3. Of seventeen patients also suffering from lung catarrh, but whose lungs appeared normal, thirteen are not quite healthy after three or four months, while in the four others the apices have become opaque.

"When the X-rays find *the transparency of the apices of the lungs reduced*; when we see *that they do not take full share in the breathing*, or are *so shrunk that they are no longer seen above the collar-bone*; and when we remember in addition that consumption generally begins in the upper third of the lungs, we shall then *with probable certainty decide on a diagnosis of phthisis in an early stage*. And we shall do this still more certainly if we find further corroborating signs in the physical examination that we next make.

"I may also state that in some suspected patients I have first fixed the seat of disease by the rays, and have then been able to prove by percussion and auscultation changes which I had previously sought for in vain before the examination with the rays. *Further*, I will suggest the possibility of observing an appearance directly with the eye which is characteristic of phthisis—I mean *the smallness of the heart*.

"Naturally, it will not be possible to make a successful diagnosis of every case by the aid of the rays. Mistakes are possible, but practice improves the diagnostician. As to the diagnosis of advanced tuberculous patches, as well as of cavities, whether superficial or deep-seated, I will state that the former give dark shadows, the latter show light patches, clearer even than the surrounding lung-tissue.

"The fluoroscope is of immense importance in estimating the prognosis in pulmonary disease. When the treatment can be begun at a time when the screen shows that changes have only just set in at the apices a perfect cure may be expected, and in advanced cases X-rays will decide whether the patient has still a chance of relief."

In other sections of this System of Instruction readers will be

taught methods of treating tuberculosis which seem to promise much better results than methods in common use. With effectiveness they combine great simplicity.

**Diagnosis of Pus.**—With reference to the possibility of demonstrating collections of pus in the lungs, the following report of a surgeon is of interest:

"I will now pass around a skiagraph which was taken to-day of the chest of an old man, fifty-five years of age, who gave a history which resembled very much that of a pneumonia, dating eight weeks before his admission to the hospital. Some four or five weeks after the onset of the pneumonia he coughed up a large amount of pus; according to his description it must have been a pint. He continued to have fever, to lose in weight and strength. A skiagraph was taken to see whether or not it would locate the pus, and while waiting for the skiagraph a needle was inserted at the point which I have marked on the skiagraph, and pus was found there. On close study of the skiagraph it will be seen that just under the left scapula and extending downward toward the median line there is outlined a shadow which corresponds quite accurately to the dulness mapped out, and from which point we withdrew the pus. Comparing the two sides, it will be seen that about the angle of the right scapula and in the inter-vertebral space there is far less shadow than on the corresponding point on the left side.

"The ability of the X-ray at times to locate pus in the chest was clearly shown in a case seen with Dr. ——. My doubts as to the existence of pus and my somewhat sceptical view that the shadow and the physical signs might be due to adhesions and thickenings, were removed by operation and evacuation of about eight ounces of pus." (HERRICK.)

**Function of Repeated Examinations.**—Reports of many cases showing the importance of repeating X-ray examinations at judicious intervals of time have been made by wise observers. The need of this is greatest in medical diagnoses of parts other than bones. A number of temporary conditions related to the heart, circulation, and state of the patient, seem to darken a part or whole of the lungs. If seen at a first examination it can readily be determined whether the lungs are affected by subsequent inspections four or five days apart. The darkened area will clear if the process was acute or secondary, while if chronic or a primary disease of the lungs the shadows will not be cleared by relief of another supposed cause. A doubtful case carefully watched for a month will reveal itself very clearly by this method. In a similar way the heart may be watched either for the progress of dilatation, or to exclude cardiac disease, or to observe



changes during treatment, or the alterations between quiet and active exercise.

Many things that are reported as visible to the eye with X-rays are only so after careful, efficient, and repeated observations, made with systematic intervals and a regulated control of the conditions most favorable to the view. Do not forget that many of the achievements of the microscope are triumphs over difficulties, and the most brilliant work of the X-ray is done by conquering whatever difficulties sundry patients present. Fine work is not a careless off-hand glance and snap diagnosis, but the result of painstaking sifting of all the facts that can be gathered by all methods of examination and interpreting them for the given case.

Those who may have erroneous ideas as to the place of X-rays in pulmonary diagnosis can set themselves right in a few lines:

1. In suspected tuberculosis (or often in cases not yet suspected) an efficient examination with X-rays by fluoroscope and radiograph is capable of determining whether the disease has or has not yet begun with greater certainty than any other method at the same date. Physical signs are absent.

2. In the early stage when physical examination can detect signs of the disease the fluoroscope confirms the diagnosis and marks out the extent of tissue affected. This service is not without value.

3. In later stages there are so many ways of making the mere diagnosis that the function of X-rays is different. Efficient X-ray examinations can watch the progress of the disease with great accuracy, reveal the extent of tissue invaded, locate the worst areas, detect or exclude certain advanced lesions, and an operator skilled in localization can many times point out where to enter the thorax for the removal of pus, etc.

Closer study of all that X-rays can do in skilled hands would surprise men whose custom it has been to over-estimate auscultation and percussion; methods which leave more to the imagination than most non-experts admit or suspect. In fact, the great part played by the imagination in physical diagnosis was not revealed till the X-ray demonstrated it. But every difficult diagnosis must be a composite process in which the X-ray takes only its legitimate part.

**Diagnosis of Diseases of the Heart and Aorta.**—It is but a short step from the lungs to the heart in X-ray examinations. The technic of one merges with the technic of the other. The interests of the two are so nearly mutual that no practitioner looking at the lungs will venture to pass by the heart.

The best view of the heart is obtained by *anterior inspection*,

and particularly *at the end of a deep inspiration* when the shadow of the heart is more or less completely separated from the diaphragm. In a thin subject the nearness of the heart to the screen creates a sharply defined shadow of the organs. In a thick subject the greater distance of the heart away from the screen causes a loss of definition, and blurring of the outline and the shadow is larger than the organ. When necessary to do so the patient may be placed at a greater distance from the tube (twenty to thirty inches) to avoid enlargement of the shadow.

It has been found that the part of the heart-shadow which shows the greatest amplitude of movement is at about the middle of its left border, where it crosses the shadow of the fourth rib. The first sound of the heart is exactly synchronous with the end of the movement of the left border toward the left. This lateral movement is therefore pre-systolic and corresponds to the period of auricular systole. By means of the fluoroscope it is clearly demonstrable that the so-called apex-beat as noted by external palpation does not in all cases correspond with the position of the apex of the heart. Change of position from the right lateral recumbent to an upright position, and thence to a left lateral, causes a change in the position of the heart amounting to nearly three-quarters of an inch. When the arch of the aorta is the object of inspection the right anterior oblique position of the patient is most favorable.

"If the size of the heart is abnormal we have an indication of disease either inside or outside of the heart. If size is normal it is not probable that any serious chronic valvular lesion is present in a young patient. The recognition of an enlarged heart being important a very large number of tests have been made by experts to determine the relative accuracy and completeness with which the outline of the heart may be mapped by percussion and by competent X-ray apparatus. The *verdict* is not only *very greatly in favor of the X-ray as an instrument of precision, but its obvious superiority needs no argument in the majority of cases*. It is also important to have a means of discovering whether the heart is abnormally *small* in proportion to the demands of the body, and an X-ray examination is incomparably beyond any other method for this purpose.

"Errors of percussion are less frequent in normal cases, but they are relatively frequent and difficult to avoid in departures from the normal size of moderate extent. Moreover, while the degree of expertness in percussion which would enable a physician to lay claim to almost unfailing accuracy in his ability to outline the heart must always be the rare possession of a few extremely gifted and highly trained men, yet the humblest physician possessed of sight may see the shadow of the heart on the screen. With the aid of the screen



accurate tracings \* may be made which show not only the size and position of the organ, but the range of its movements. These tracings can be made in less time than would be spent in percussion. Each border of the heart can be separately examined with the shadow but little magnified and practically free from distortion. It is only necessary to put the patient in the right position in relation to the tube and screen and regulate the degree of radiance. Percussion may give excellent indications of what lies near the inner side of the chest-wall while the X-ray reveals the entire width and length of the heart. The best view of the heart is obtained during full inspiration when the intercostal spaces are increased and the descent of the diaphragm makes the axis of the heart more vertical than during expiration.

"When the lungs are transparent and the patient not too muscular the X-ray enables the outlines of the ventricles to be made out more accurately than by percussion. Another advantage of great importance is that a displaced part is not mistaken for an enlarged one. If the heart is increased in size it can be ascertained whether the right or left ventricles are enlarged. In favorable subjects enlargement of the auricles, more especially that of the right side, can be distinguished. These diagnostic possibilities of the X-ray are of particular value in the early stages of cardiac enlargement when so much more benefit can be hoped from treatment than in later stages of disease."

Exact directions for cardiac exposures, both for fluoroscopic and radiographic examinations, are taught in Chapter XV. on Selected Operative Technics. Those especially interested in measuring the size and outlines of the organ may refer to description of the author's heart-shadow outliner in Chapter XI.

**Study of the "Heart-Reflex" with X-Rays.**—"What I have referred to as the *heart-reflex* pertains to a curious phenomenon which is only manifest by means of the X-rays and the fluoroscope. It is a contraction of the myocardium reflexly induced by irritation of the skin in the precordial region. The illumination of the thorax by aid of the X-rays furnishes us with a comprehensive view of the *situs viscerum thoracis in vivo*, together with the functional phenomena of the viscera. The movements of the heart are first manifest in the left ventricle, beginning at a point about two centimetres from the apex of the organ. The active changes observed have been likened to the opening and closing of a lid and vary in frequency and extent. In some instances, the change in form is manifested by rapidly recurring light and dark shadows. A change in the position of the apex is only rarely observed. At times one may note the isolated contractions of the muscles and ventricles and even recognize the time interval between the contractions. A change in the form of the right ventricle is rarely observed, although in some individuals it is very

\* For directions see Chapter XI.

apparent. A little practice soon enables one to trace the outline of the heart on the chest-wall with a *dermograph in a metallic casing*. The entire outline of the heart may be determined from the *anterior* surface of the chest, whereas the heart-view from the *back* shows only a portion of the organ, owing to its position in front of the vertebral column and the oblique site of the organ in the thorax.

"The heart-reflex is best studied with the fluorescent screen approximating the *anterior* chest-wall. The reflex is especially pronounced in children, and is best seen in adults with thoraces scantily furnished with musculature and panniculus. If we irritate the skin of the thorax in the precordial region by vigorous rubbing with a blunt instrument, a contraction of the myocardium is observed. Myocardial contraction is, as a rule, more manifest in the left than in the right ventricle. The contraction thus induced reflexly is sudden and of momentary duration, and, like other reflex acts, soon becomes exhausted. The degree of myocardial recession varies greatly. In some persons it is scarcely perceptible, while in other individuals it may recede fully an inch on either side upon the first application of the cutaneous irritant. The ether-spray is unquestionably the best cutaneous irritant, but its use necessitates the employment of an assistant. Stimulation of the centre for the inhibitory nerves of the heart reflexly by centripetal nerves is an adequate explanation for the heart-reflex. It is a physiologic axiom that stimulation of the respiratory centre is greater through the cutaneous nerves than through the vagus branches to the respiratory organs.

"In diagnosis, the heart-reflex may serve as an index to the condition of the myocardium. Observation has taught me that when the heart-muscle is healthy, the reflex is active and vigorous, while in degeneration of the muscle it is feeble or absent. In pericardial exudates and pericardial synechiæ it is likewise absent.

"In the treatment of chronic heart-disease by balneotherapeutics, mechanotherapeutics (Schott treatment), I believe that the heart-reflex must be taken into account. I refer to the reduction in the area of heart dulness after the resistance-movements and the baths to cutaneous irritation, and think that the myocardium responds to the Schott treatment irrespective of any other factor beyond reflex-contraction of a muscle following peripheral stimulation of cutaneous sensory nerves. In many of my patients I employ vigorous cutaneous frictions, in lieu of the conventional Schott treatment, on account of its being simpler, more expeditious, and less expensive. The results have been nearly as good as with the Schott treatment. Relief of dyspnoea follows, and there is marked reduction of the pulse-rate, together with an increase in volume and force." (ABRAMS.)

In the author's volume on Static Electricity the reader will be instructed in methods of treatment which are deemed very much simpler and very much better for the patient than the classical method of Nauheim.



**Chronic Pericarditis.**—The X-rays may possibly help in the diagnosis of an adherent pericardium. Ordinarily the movements of the heart are well shown in different positions of the body. If the visceral and parietal layers of pericardium are adherent to themselves and to the chest-wall and pleura, the limitation of movement which might then be observed would be a factor in the diagnosis.

After pericarditis the heart is larger and the entire muscle casts a darker shadow than a normal organ. It is also stated that a rapid heart action permits a better outline in the radiograph than a slow beat, as the heart then occupies its marginal positions most frequently, and secures more effect of the exposure. Much of the clearness of the heart in a radiograph depends on the structure of the patient. A lean muscular subject is the ideal, largely because the heart then approaches nearest the film and casts a sharp shadow. A fat person blurs the heart-shadow on both screen and film, chiefly because the thick mass of tissues in front of the heart removes the organ so far back from the film that the effect of the crossing of the rays fogs the margins, and the increased distance between the heart and the front surface lessens the contrast. Remember that all the information obtainable by X-rays cannot be secured in every case. Some cases present difficulties that are wholly absent in others.

**Slow Pulse.**—Relative to the characteristics of slow pulse a unique observation is that of Auché and Martin, who examined, by means of the fluoroscope, a man subject to attacks of vertigo, who had habitually a pulse of about forty. They report "the cardiac contraction is brisk and does not last longer than ordinarily. Dilatation is rapid, but when it is accomplished the heart rests. During the whole of the long pause ('grand silence') it is impossible to determine the least contraction of auricles or ventricles. There is no abortive systole." Information of this kind could not be obtained without the aid of X-rays.

**Aneurism.**—In writing of the value of X-ray examinations in some of the less frequent diseases of the chest, Williams states that aneurisms of the thoracic aorta may be seen by the X-rays *before there are physical signs*. This method of examination may give us greater assurance of the absence of an aneurism of the aorta in suspected cases than any other evidence that we can have.

He reports the examination of thirty-four cases, fifteen having typical aneurisms, six had more or less dilatation of some portion of the arch, one showed an outline suggestive of aneurism, but there was no pulsation and on autopsy a mass of glands was found. The remainder gave normal outlines in the region where an aneurism had been suspected.

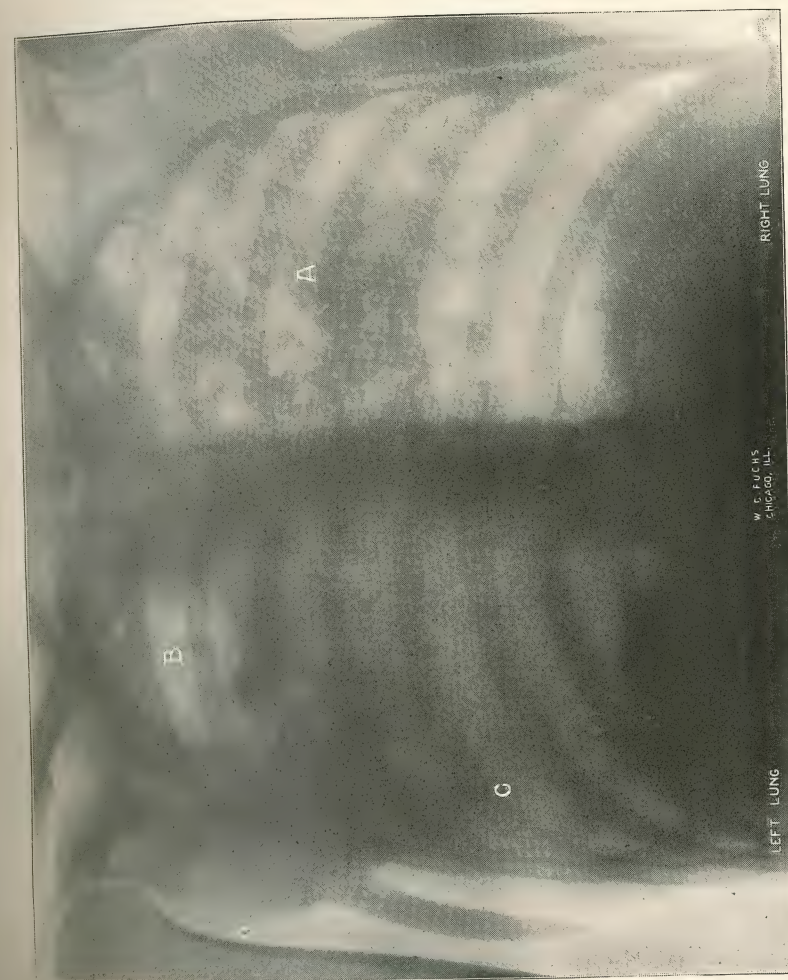


PLATE 149.—Tuberculosis with cavity in left apex. "B" marks the cavity; "C" marks darkened area of extensively diseased lung of same side; "A" marks upper half of right lung with moderate consolidation and disease.



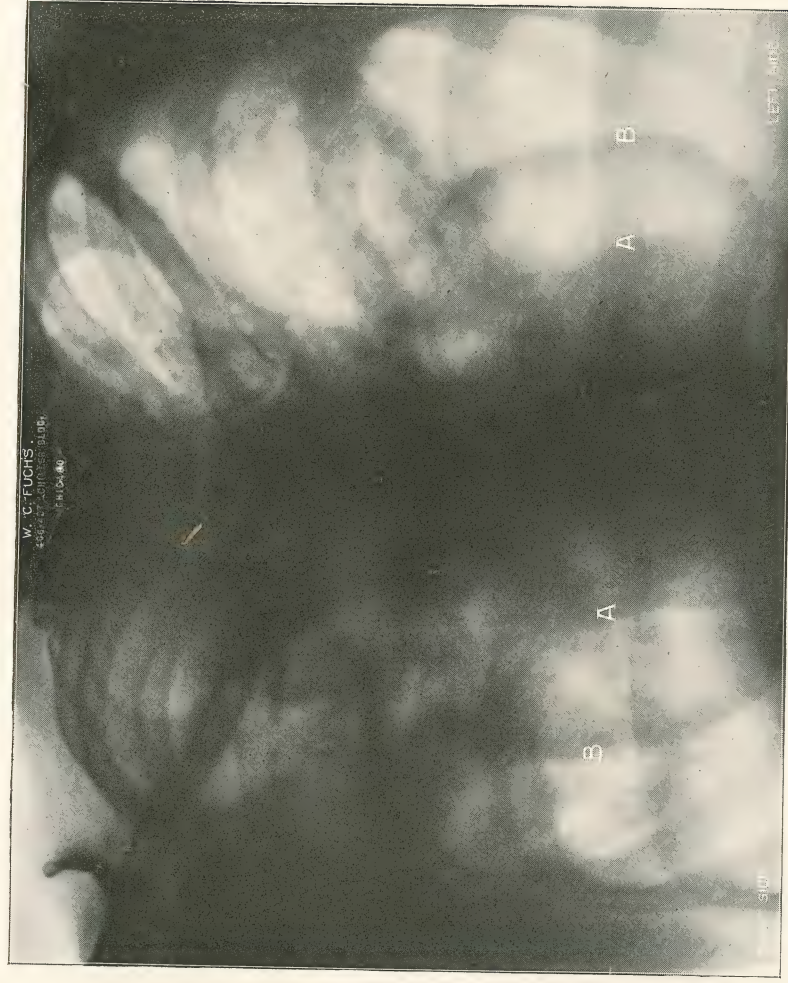


PLATE 150.—Radiograph of case of pericarditis with effusion and showing tuberculosis of the right lung and the distended pericardial sac. To get normal view hold this cut in front of mirror with a good side-light. "A" mark heart boundary; "B" mark sac boundary. Clinical diagnosis agreed.

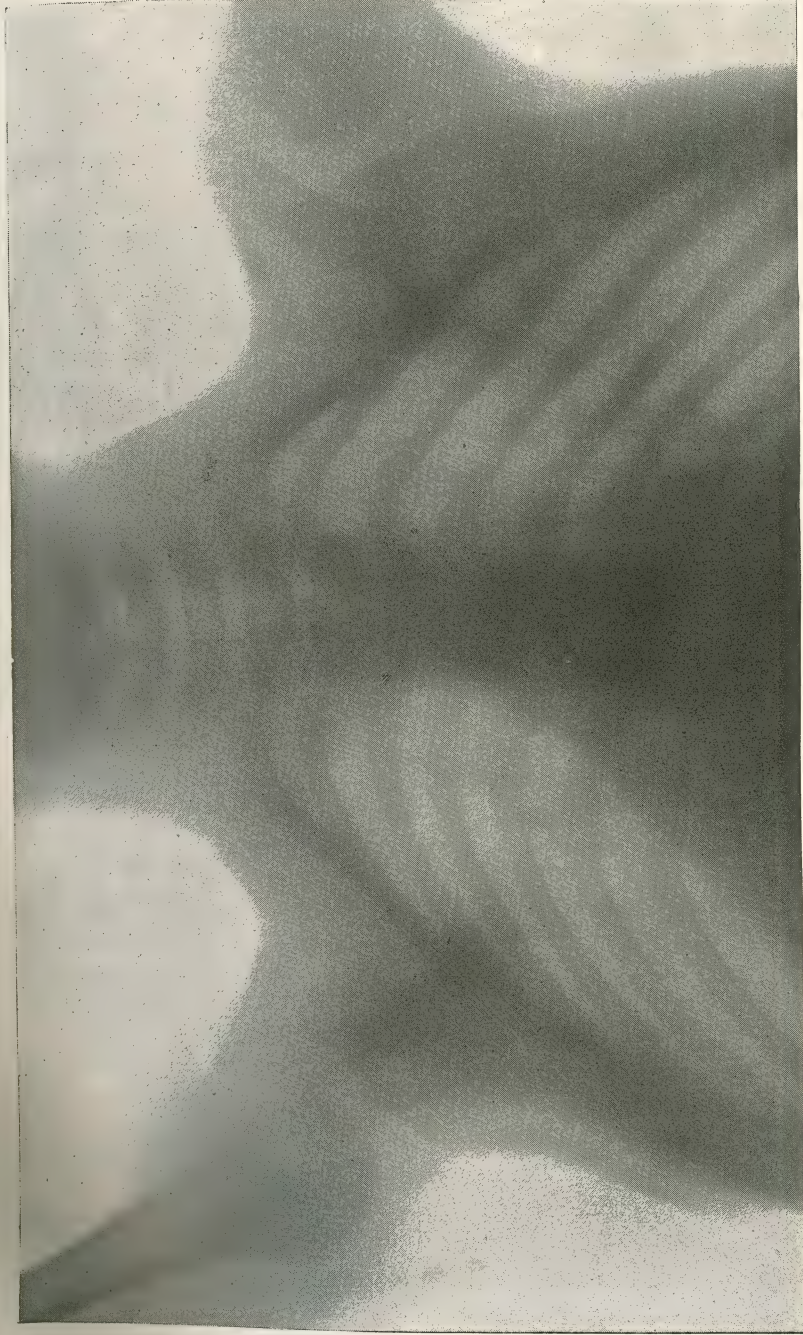


PLATE 151.—Congenital absence of the clavicles in a girl of fourteen. On one side a short portion of a clavicle can be seen, but the opposite bone appears to be entirely absent. The patient's shoulders can be brought together in front of the body. (Rehman, Ltd.)



In thirteen of the fifteen cases the aortic arch was the seat of the aneurism; in one of these there was a second aneurism in the innominate artery also; in the fourteenth case there were two aneurisms, one in the innominate and another in the subclavian artery; in the fifteenth case the aneurism was in the subclavian artery.

The physical examination of twelve out of fourteen of the cases of aortic aneurism was given in the hospital records; in five cases there were no physical signs of aneurism; in eight cases the heart was enlarged, and in five of these there were murmurs indicative of valvular defects, four of which were aortic and one mitral. Arterio-sclerosis was found in the three cases in which an autopsy was made. No nephritis was found in any case. *A transverse position of the heart* is believed to be an important diagnostic sign of intrathoracic aneurism.

In cases of aneurism X-ray examinations are of special value as an aid to prognosis, and their results tend to prove that the functional disturbances are sometimes in inverse rather than in direct proportion to the gravity of the lesion.



## CHAPTER XXXV

### THE FLUOROSCOPE IN PLEURITIC EFFUSIONS

#### STUDIES IN THE EXAMINATION OF CLINICAL CASES.

In December, 1896, Professor Bouchard published observations with the fluoroscope and laid down the following dictum:

*"When opacity of great extent is not accompanied by displacement of the mediastinum it is more probably caused by pulmonary infiltration than by pleural effusion. Per contra if the opacity becomes gradually more pronounced from above downward, and if the heart is displaced, while the other side is transparent, there is probably effusion."*

Within a year these diagnostic conclusions were confirmed by clinical reports of Bergonie, Beclère, Oudin, Barthelémy, Williams, and others. In effusions of the left side the heart may be seen displaced to the right even when the displacement cannot be demonstrated by percussion. In the classical report of MM. Bergonie and Carrière, published \* February, 1900, the investigators used a twelve-inch coil excited by twenty secondary cells controlled by a rheostat. The tubes were required to give a sharp definition of the ribs. A couch was used; a wooden frame two feet wide covered with vegetable hair-cloth and a thin water-proof fabric so transparent that its shadow could hardly be noticed on the screen. The examinations were made in the evening in a dark-room kept at even temperature, and the patients were brought in without fatigue or exposure. A full physical examination of each case was then made by the usual clinical methods. The lines of dulness were then marked on the skin by a dermal pencil, and a lead-wire fastened over this to define the area on the fluoroscope. Afterward a second line was marked showing the areas of opacity revealed by the rays. Notes were then made as to the agreement or non-agreement of the different tracings. When working many hours in the darkness the eyes became able to see differences that at first escaped observation. All examinations were made in the following methodical manner:

\* Archives of the Roentgen Ray.

1. Patient seated on couch with tube behind his back and screen placed on chest.
2. Tube in front of anterior wall of thorax and screen on back.
3. Patient in dorsal decubitus on couch; tube under couch; screen on thorax.
4. Patient laid on couch, first on right, then on left side, and tube and screen on opposite sides in alternation.
5. Lastly, examinations were made with patient on his abdomen.

Aware of the difficulties of the observations and the liability of error in interpretation a great variety of tests were made with many tubes in many different positions and at various distances, and every effort was made to arrive at correct conclusions. An attempt will be here made to so condense this immensely valuable report as to yield the greatest amount of instruction in the least space. We regret that the entire history of the cases cannot be included.

"Case 1.—Right pleuritic effusion due to chill. With the tube posteriorly and the patient sitting, the fluoroscopic opacity exactly coincided with the dulness. The lung above was transparent without any dark spot. The transverse lines in Fig. 1 represent the ribs. The left side was completely transparent, and here the movements of the diaphragm could be seen plainly. The apex of the heart followed the movements of the diaphragm and was lowered 2.75 centimetres in normal and 3 centimetres in deep inspiration, and beat exactly at the places where it was determined clinically. The collection of fluid (the opaque area) was raised by expiration and lowered by inspiration. On succussion no oscillation of the surface could be seen. (See Plates for illustration of the cases.)

"With tube in front, patient seated (Fig. 2), there was perfect transparency on the left side except along the spine, where there was an opaque area showing expansive movements synchronous with the systolic beatings of the heart. On the right opacity was seen extending upward to two fingers' breadth below the spine of the scapula. The lower margin of the opacity was horizontal, and the vertebral angle of the curve of Damoiseau was not apparent. The liquid was elevated with each movement of respiration.

"Fig. 3. Patient lying on back with tube under couch. Absolute transparency of the left side and total opacity of the right. The apex of the heart beat under the left nipple almost in its normal place, 8.5 centimetres from the median line and behind the fifth rib.

"Fig. 4 shows the right lateral decubitus with no interesting results. The limit of the opacity could be very plainly seen in this position.

"Paracentesis removed 2.65 litres of fluid, and the patient recovered fifteen days later.

"Remarks. The displacement of the heart was verified by the



fluoroscope and was most marked in the sitting position. The apex of the heart followed the movements of the diaphragm. The surface of the collection of fluid followed the movements of respiration. Changes in position of the patient changed the gravitation of the fluid, and all the right half of the chest became opaque in dorsal decubitus. *The absence of any opaque spot in the lung indicated that there was no accompanying pulmonary lesion. This sign has an enormous prognostic value as it declares the integrity of the parenchyma of the lung.*

"Case 2.—Right pleuritic effusion of tubercular origin; paracentesis; removal of 2.8 litres of fluid and return of same with all symptoms three weeks later. Patient then examined with fluoroscope. Fig. 1. Tube behind the seated patient.

"All left side transparent except some opaque patches here and there. On the right side the opacity formed a complete curve, concave above; the higher part of which was two fingers' breadth below the limit of dullness. Between the upper part of this curve and the line of dullness was a slightly shaded zone, and there were some opaque patches in the lung above. The apex of the heart could be seen beating in the fifth intercostal space, four centimetres inside the nipple line. It did not follow the movements of the diaphragm, which were slight.

"Fig. 5. Tube in front, with patient seated. All the left side was transparent, except some opaque patches at the apex. On the right the apex of the lung was almost perfectly transparent. The fluoroscopic opacity described a curve with the concavity upward, the upper part of which was about five centimetres below the dull area, and the left arc of which ascended the spine some distance.

"Fig. 6. Patient in dorsal decubitus. Left side transparent. Complete opacity on the right. Apex of heart displaced and beat in the fifth interspace and on the nipple line. In the left lateral decubitus there was the same displacement of the apex. The patient died soon after, and an autopsy showed that the right lung was adherent by its anterior surface to the chest-wall and was immersed in the fluid. The fact that dullness described a curve with convexity upward, while the screen opacity reversed this and showed concavity upward, *was thus accounted for.* The more transparent lung adherent and dipping into the fluid reduced the opacity of the latter by thinning its density in the area occupied by lung-tissue. Were nothing but fluid in the cavity the upper line would be nearly level on the screen with the patient in a sitting position, but *with part of the fluid displaced its shadow varied according to its thickness*; this being greatest at the sides produced the curve. This case verified the conclusion of the Godard prize essay that in a right pleural effusion of 2.5 litres the apex of the heart is depressed and approaches the middle line; also, that this lateral displacement disappears in dorsal decubitus and in left lateral decubitus. We noted that in dorsal decubitus the fluoroscopic opacity occupied the whole of the right side of the thorax, which proves that the liquid was displaced and gravitated into the

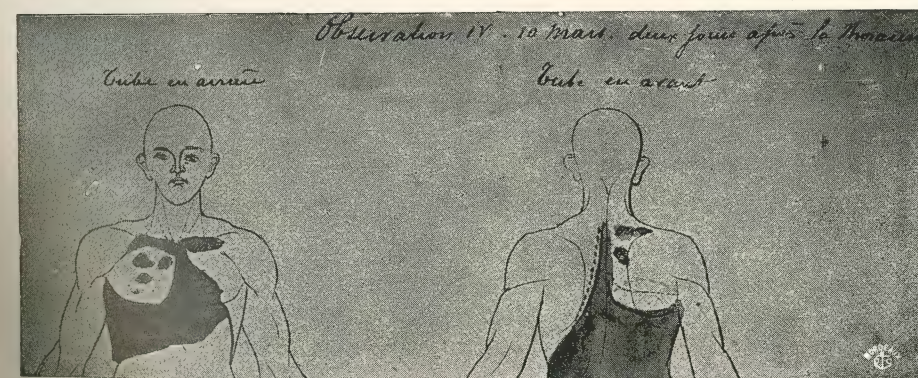
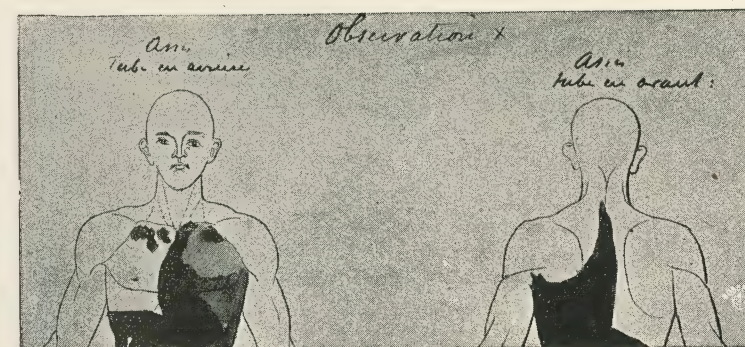
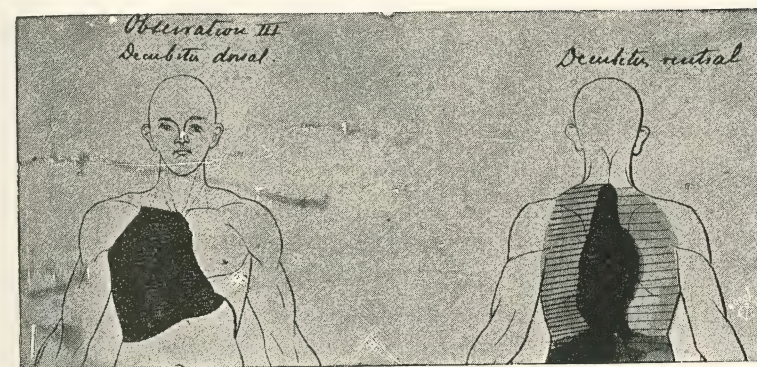


PLATE 153.—Case 1. Right Pleuritic Effusion from a chill. (Rebman, Ltd.)



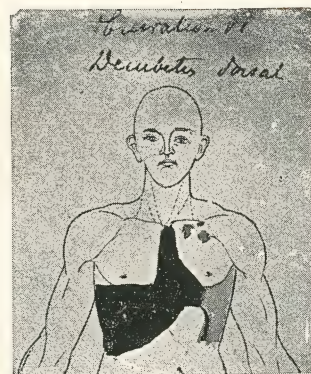
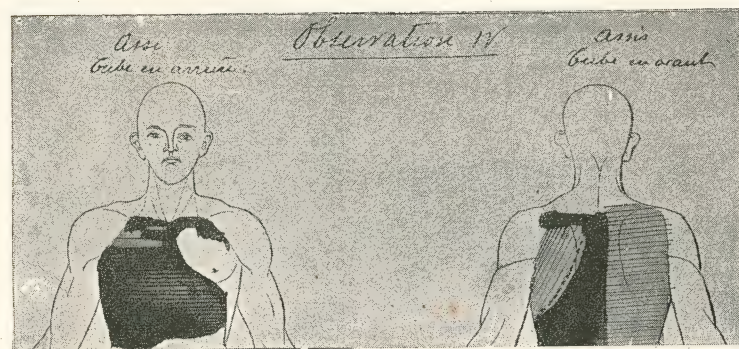
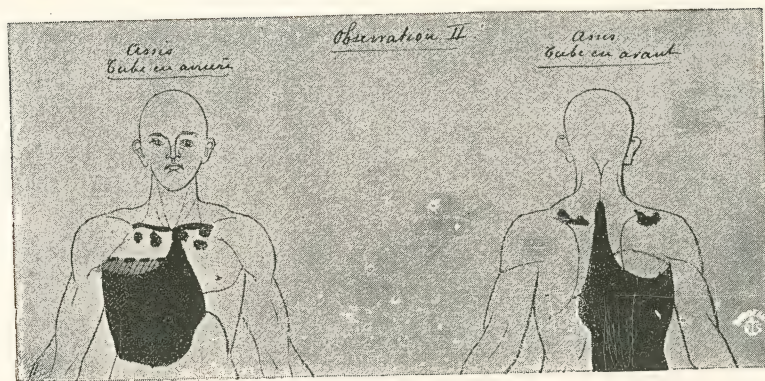


PLATE 154.—Case 2. Right Pleuritic Effusion—Tubercular with Adhesions. (Rebman, Ltd.)

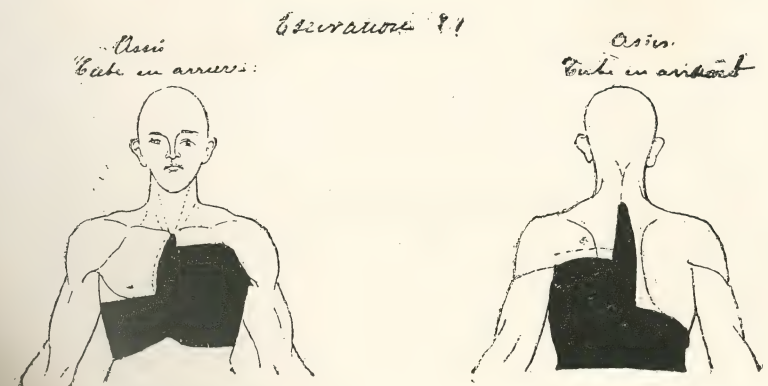
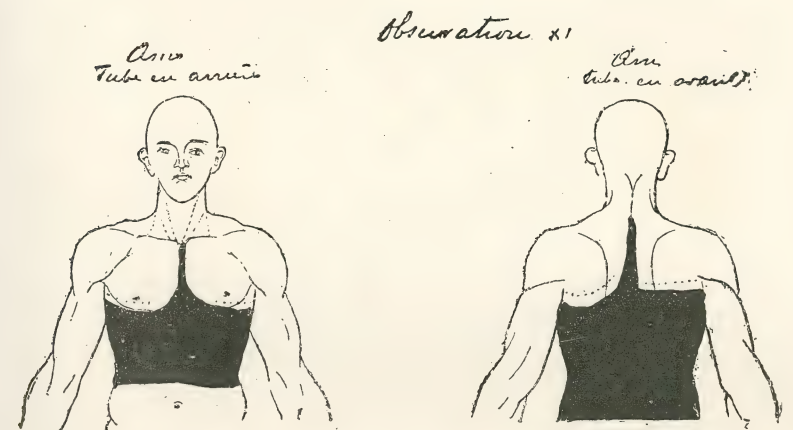


PLATE 155.—Case 3. Right Pleuritic Effusion. (Rebman, Ltd.)



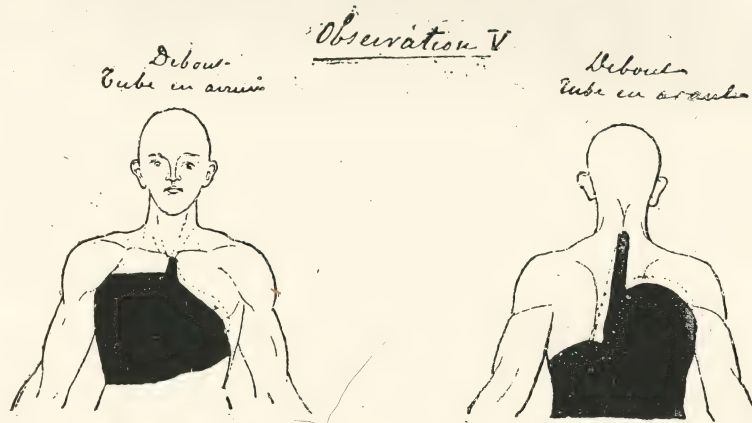
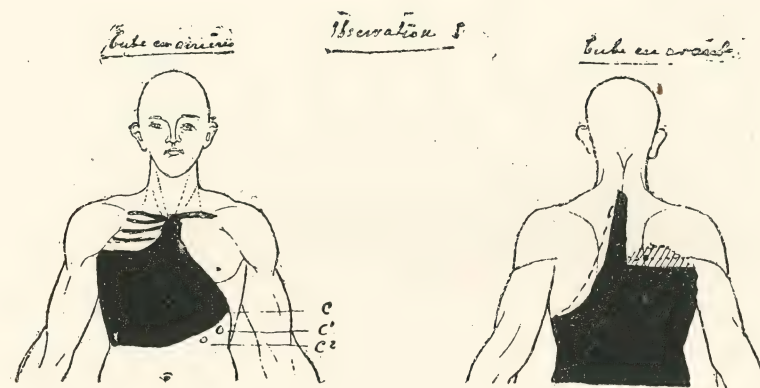


PLATE 156.—Case 3. Continued. Right Pleuritic Effusion. (Rebman, Ltd.)

costal groove when the patient was on his back. The opaque spots seen in the lung with the fluoroscope corresponded to tuberculous foci found at the autopsy.

"Case 3.—Male, aged twenty-two, acute pleurisy on right side following severe fall on edge of pavement. Tapping removed three litres of sero-fibrinous fluid, about half of which quantity reappeared a month later. Fluoroscope was then used.

"In this case three things seem worthy of remark. The displacement of the heart was less pronounced in dorsal decubitus than in the sitting position. The displacement of the fluid followed the movements of the patient and the movements of respiration. The line of opacity did not correspond with the curve of Damoiseau.

"Case 4.—Relapsing pleuritic effusions which had been evacuated four times in four months and supposed to be tuberculous infection. Fluid present estimated at two litres. Fluoroscope now revealed as follows:

"1. Patient seated with tube behind. Left side transparent except at apex of lung, where there were some irregular diffused patches which were doubtless foci of tubercular disease. The apex of the heart beat where it had been determined clinically, and rose two and one-half centimetres in normal and three centimetres in deep respirations. On the right there was complete opacity below the second intercostal space. Above that was a semi-clear area with dark spots.

"Fig. 12. Patient seated with tube in front. Almost perfect transparency of the left side except toward the upper part where, along the vertebral column, there was a dark triangular area, with its apex above and at the level of the second dorsal vertebra. This dark area was pushed to the right by each movement of respiration. On the right there was diffused opacity of the whole side.

"Fig. 13. In dorsal decubitus the same appearances were presented. The chest was tapped two weeks later and 2.2 litres of fluid removed. The next day a second fluoroscopic examination showed:

"Fig. 14. Patient standing with tube in front. Left side transparent except at the apex, where there were some opaque patches. On the right, disseminated opaque patches at the apex, with a semi-opacity of the lower part of the lung, much less in extent than before paracentesis, which presented a very curved outline with its concavity upward, and was raised with every expiration.

"Fig. 15. Patient standing with tube behind showed some opaque spots in both lungs. In this examination the following particulars are worthy of observation:

"1. The displacements of the heart, which followed the positions of the patient and the respiratory movements.

"2. The opaque spots, indicating without doubt tubercular foci.

"3. The existence of an opaque triangular area posteriorly, to the left of the spine, having expansive movements synchronous with respiration. This was probably only the mediastinum which was pushed to the left by each expiration.



"Case 5.—Male, aged twenty-five, right acute pleurisy with effusion estimated at two litres, the result of a chill.

"1. Fig. 16. Patient standing, with tube behind. Perfect transparency on the left side. On the right, complete opacity, except at the level of the first interspace, above which was absolute transparency. On the left the apex of the heart was seen beating in the fifth interspace, 13.5 centimetres from the middle line. It was raised 2.75 centimetres in normal expiration, and about 3.5 centimetres in forced expiration. (Other postures omitted for lack of space.)

"Paracentesis was performed February 25th, and about 2.5 litres of sero-fibrinary liquid was drawn off. The following points are worthy of note in this case:

"1. The displacements of the heart varying with the position of the patient and the movements of respiration.

"2. The oscillation of the surface of the liquid at each respiratory movement.

"3. The displacement of the liquid with each change of position of the patient.

"4. The displacement of the left of the mediastinum at each expiration, a phenomenon also observed in Case 4.

"5. *The perfect transparency of the right lung above the effusion, indicating the integrity of the pulmonary parenchyma.* This was eventually corroborated by the complete recovery of the patient.

"6. We would draw special attention to the shape of the upper part of area, which was *convex*. This indicated, in our opinion, that *there was no adhesion between the lung and the costal parietes.*

"Case 6.—Male, aged twenty-eight. Left pleuritic effusion, with some tubercular patches at the apex. (Details of postures and findings omitted.)

"The patient afterward became the subject of dorso-lumbar Pott's disease. The following points are worthy of note in this case:

"1. The displacement of the liquid in changes of position of the patient.

"2. Its displacement in respiratory movements.

"3. *The presence of shaded patches at the left apex, which indicated that tubercular infiltration was commencing there, and this opinion was verified later by the appearance of moist râles in that situation.*

"Case 7.—Left pleurisy from a chill with effusion estimated at 2.8 litres. Puncture evacuated 2.9 litres of fibro-serous liquid. The following points are worthy of note in this case:

"1. The perfect coincidence of the limits of the fluoroscopic opacity and the dulness.

"2. Displacement of the liquid with respiratory movements and changes of position of the patient.

"3. The movements of the upper level of the fluoroscopic opacity on forced expiratory movements, which seemed to corroborate the theory of Roesbach.

"Case 8.—Male, aged twenty-two. Left tubercular effusion.

"The following points are worthy of note in this case:

"1. It was not always possible to locate the apex of the heart exactly. It was not under the right breast, as the pulsation observed would have led one to suppose, but under the sternum.

"2. Displacement of the fluid in changes of position of the patient.

"3. *The existence of shaded spots at the apex of the lungs which led us to think that tubercular infiltration was beginning in the lung-tissue, and this was verified later in the case.* The day after the examination 3.10 litres of fluid were evacuated.

"Case 9.—Female, aged twenty-six. Purulent pleurisy. Two litres of pus evacuated. The effusion reformed and she became hectic. The fluoroscopic examination then showed: (Details omitted.)

"This observation scarcely gave any precise results. It showed, however, that in *left* pleuritic effusions no decided conclusion had been come to as to the position of the apex of the heart from a fluoroscopic examination. It is interesting to note, however, that purulent liquid arrests the passage of X-rays through it nearly as much as does sero-fibrinous liquid; but the opacity is less *complete* in the former than in the latter, since, through the former, the shadows of the ribs may be perceived. *This may perhaps prove to be important in making a differential diagnosis.*

"Case 10.—Female, with signs of considerable left pleuritic effusion; nevertheless, four exploratory tapplings gave only negative results. After a careful clinic examination a diagnosis was made of tubercular infiltration of the left lung with slight pleuritic effusion. A fluoroscopic examination was next made.

"1. Fig. 29. Patient seated with tube behind. Almost perfect transparency of the right side, except at the apex where there were some opaque spots of small extent. On the left the upper limit of the opacity followed exactly the line of clinical dulness. The upper part slightly shaded with a diffused opaque patch in it. There was a very dark area running obliquely down the sternum and toward the right nipple, and continuous with the main dark area below. On the right side the convexity of the diaphragm was well marked. The shaded area down the sternum passed the middle line to the right at each expiration, and went back again at each inspiration. These movements were absolutely synchronous with those of the diaphragm. The outline of the heart could not be seen at all, as its shadow was within the dark area.

"2. Fig. 30. Patient seated with tube in front. Perfect transparency of the right side, the movements of the diaphragm being well seen. On the left the line of opacity corresponded at its upper limits to that of the dulness, and described a curve with its concavity upward.

"It was convexed toward the right and extended above the shoulders to the second dorsal vertebra (mediastinum).

"Fig. 31. In dorsal decubitus. On the right the result ob-



tained was the same as in the sitting posture. On the left was opacity, which, instead of being limited as in the sitting posture, occupied the whole of the chest.

"4. Fig. 32. In ventral decubitus, the right side presented the same characteristics as in the previous positions. On the left there was diffused opacity of the whole side.

"5. Fig. 33. Right lateral decubitus with the tube behind. Transparency on the right side. On the left, some opacity.

"6. Fig. 34. Tube in front. Right side transparent. On the left there was a triangular opacity running up the spine with its base below reaching from the spine to the axilla. The points worthy of note in this observation are:

"1. Displacement of the fluid in changes of position of the patient.

"2. The importance of the fluoroscopic examination as it revealed the existence of the foci of tubercular infiltration in the lungs.

"3. Displacement of the mediastinum toward the right during the expiration, which will be explained presently.

"4. The form of the upper limit of the opacity which was opposite to that of the classic curve of Damoiseau. This anomaly received a natural explanation in the sequel.

"The patient ultimately died, and a post-mortem showed that the left lung was adherent by its anterior surface to the walls of the chest, and was consequently immersed in the effusion, causing it to give at its upper part only a semi-opaque shadow and throwing the upper margin of the opaque liquid out of shape.

"Case 11.—Male, clinical diagnosis; tuberculosis of the peritoneal pleura, with double pleuritic effusion of a tubercular origin. This diagnosis was verified by exploratory tapplings. He was next examined with a fluoroscope.

"This case was interesting from several points of view. We may note:

"1. The verification by fluoroscopic examination of the clinical diagnosis of a double pleuritic effusion.

"2. Displacement of the fluid in respiratory movements.

"3. The movements communicated to the collection of fluid on the left side by the pulsation of the heart.

"4. The horizontal line of the water-level on the right behind.

"In our opinion these observations in their relations to the clinical facts noted before each of them lead us to some interesting deductions. It has been shown that pleuritic effusions do not allow X-rays to pass through them, and that the hemithorax affected presented a very marked opacity on the screen. It seems to us that *this opacity is directly in proportion to the amount of effusion*. When there is a collection of *pus* in the pleura the opacity seems less complete than when there is an effusion of *serum*. In the former case there is only a dimness, more or less considerable according to the amount of effusion. The lower boundary of a pleuritic effusion is as a rule but

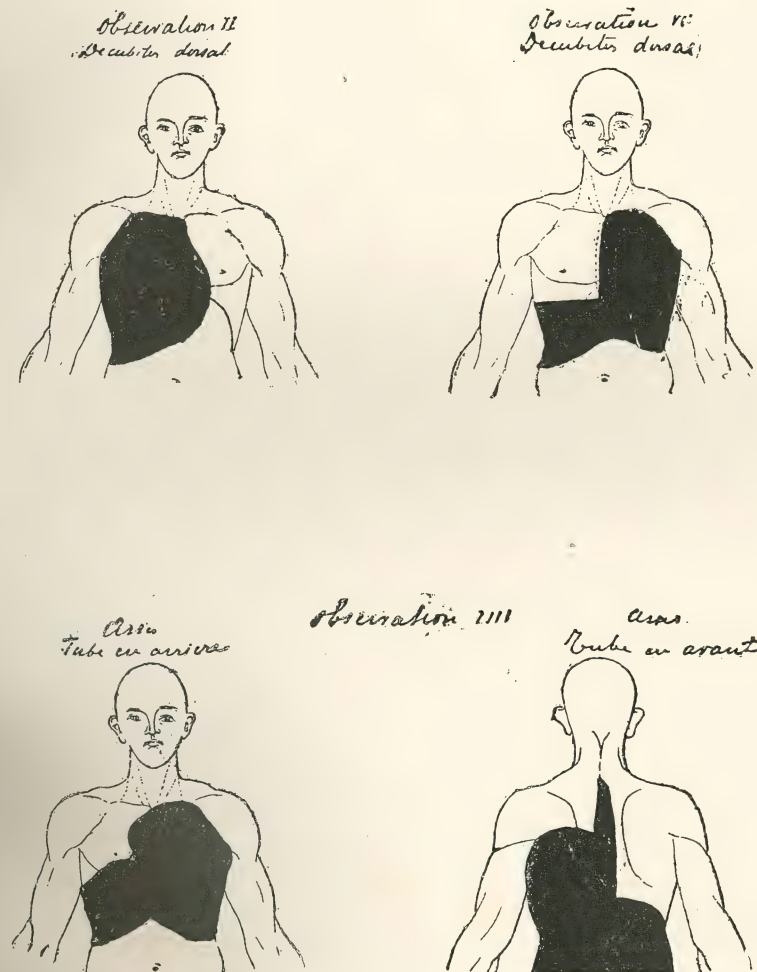


PLATE 157.—Case 4. Right Pleuritic Effusion of Bacillary Origin. First Examination. (Rebman, Ltd.)



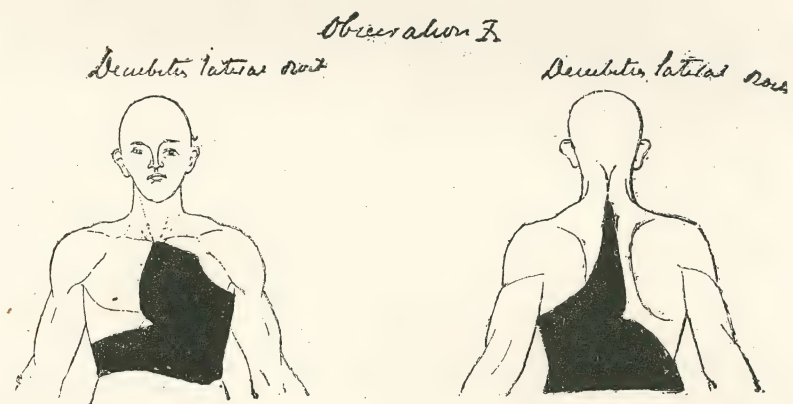
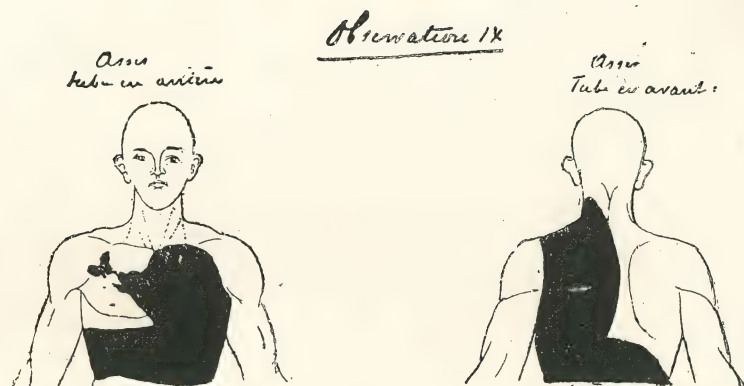


PLATE 158.—Case 4. Continued. Second Examination—after Tapping. (Rebman, Ltd.)

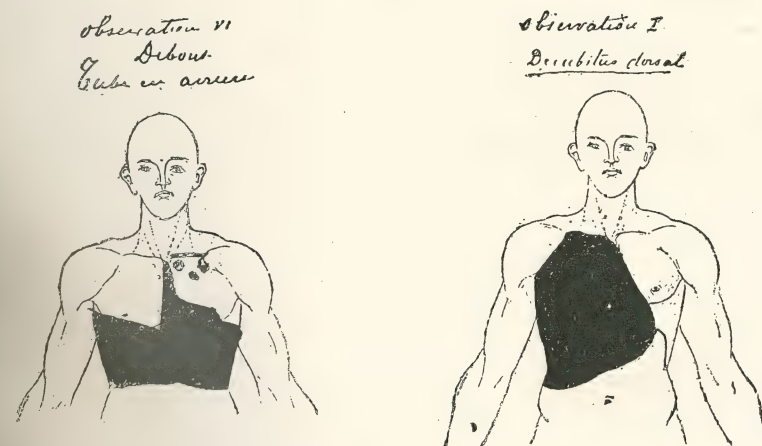
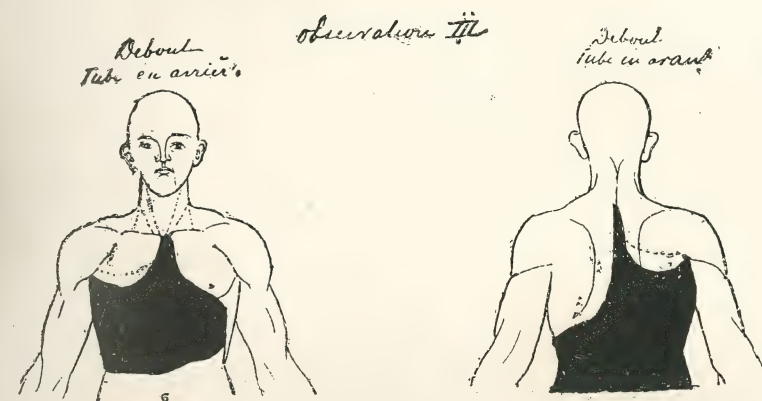


PLATE 159.—Case 5. Right Pleurisy from a Chill.



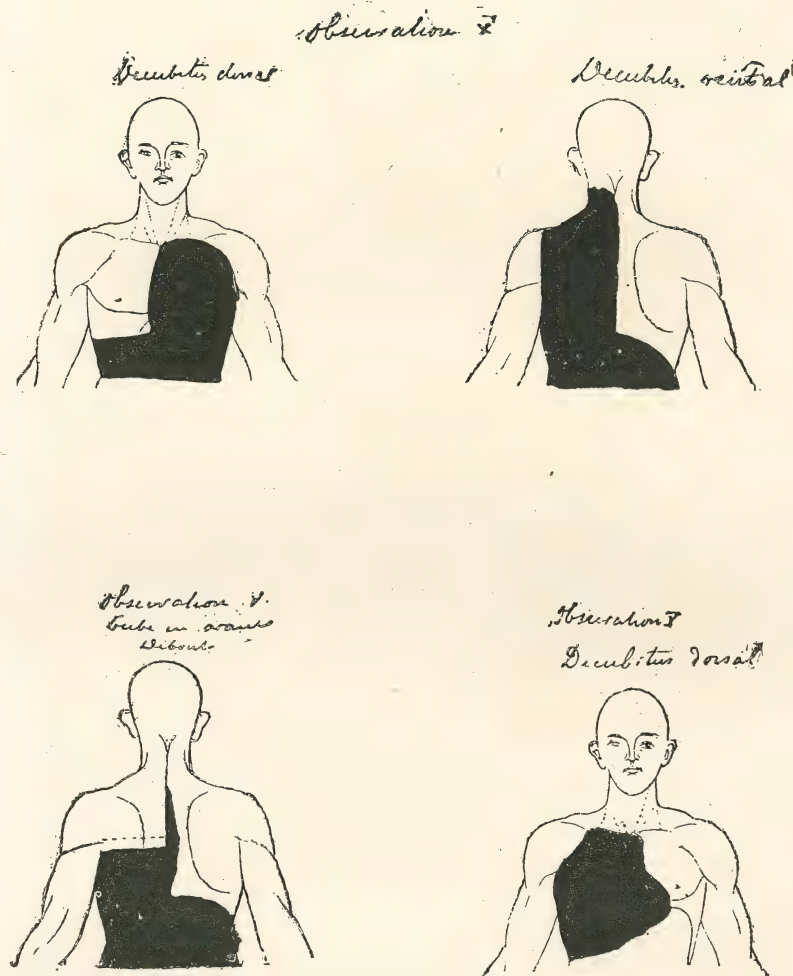


PLATE 160.—Case 6. Left Pleurisy with Effusion—Tubercular.

little defined, especially on the right, where it blends insensibly with the opacity caused by the liver. The upper boundary is generally very clear and sharp, and presents variable appearances:

"It may coincide with the curve of Damoiseau.

"It may be concave above (opposite to that curve).

"It may be horizontal.

"When the upper surface of the liquid presents (both to percussion and to the fluoroscope), the classic curve of Damoiseau, we may be sure that the convex part corresponds to a hyperæmic or atelectic area; for if we make the patient cough violently, or take four or five deep inspirations, we may see that the surface becomes horizontal instead of convex. Often the upper margin is horizontal, even when the line of dulness or percussion follows the curve of Damoiseau. Lastly, in some rare cases the upper limit of the opacity is concave above. We have seen some such, and we think that we can explain the phenomenon. In these cases the lung which is adherent to the costal parietes, dips more or less deeply into the liquid, and the upper part of the effusion occupied also by the lung is partly transparent, and thus the margin of the opacity seems to be concave above.

"It is by no means rare to see alterations in the shape or situation of the upper surface, and these are sometimes synchronous with the pulsation with the heart. More frequently, however, these alterations are caused by inspiration or expiration. The surface is lowered by the former and raised by the latter. This phenomenon is easy of explanation, for in expiration the cavity of the thorax becomes contracted and the compressed effused liquid is raised.

"M. Mignon says that in hydropneumothorax the movements of the patient cause an agitation at the dark surface of the liquid. We have never been able to get this wave-like movement in any cases we have examined. We do, however, get displacements of the whole collection of the fluid with changes of position of the patient. We have been able to convince ourselves of the presence of such displacements by percussion, and have afterward found them even more evident on the fluoroscope. In dorsal decubitus the fluid collects in the posterior thoracic grooves, so that there is no margin to the opacity and all the side is opaque. There is also total opacity in ventral decubitus.

"It is in the study of displacements of the heart that the fluoroscope renders us the greatest service, since percussion and the phonendoscope give only negative indications on this subject. Thus, we have observed that in effusions on the right side of small amount there is little or no displacement of the apex in dorsal decubitus. When the patient has been caused to sit or lie on his left side we have seen a displacement toward the left from three to five centimetres. In a healthy man we have never seen the heart displaced by changes of position in this way, but, though there is no lateral movement, it is lowered two or three centimetres in inspiration. With effusions on the right of considerable amount we have noticed displacements of the heart to the left, but changes of position do not make



much difference to it. In *left-sided effusions* the problem is more interesting, for here we touch the grave question of the possibility of torsion of the heart. One of us, in an essay to which a prize was awarded by the University of Bordeaux, July, 1897, gave the experimental and clinical reasons which were opposed to the possibility of such torsion taking place.

Professor Bouchard has demonstrated the existence of *an opaque area to the right of the spine which disappears on expiration*. He thought it was produced by the dilatation of the right auricle. We have observed it in one case, but what we have more often noticed is the existence of a triangular opaque area to the right of the spine increasing in size with expiration and diminishing in inspiration. It is probable that this is due to displacements of the mediastinum. During expiration the depression in the left pleura, when it encloses the effusion, attains its maximum, and the only one of all the parts bounding the thorax, which is movable and passive during expiration, is the *mediastinum*, the diaphragm being contracted. It is, consequently, *driven to the right in expiration*. The fluoroscope also allows us to study the movements of the *diaphragm* in pleuritic patients. The half of the arch which corresponds with the effusion scarcely makes any movement, while the other half makes up the deficiency by exaggerated movements. Lastly, we may add that by the aid of the fluoroscope we may pretty accurately form a *prognosis* in cases of pleuritic effusion. Many authors have insisted on the value of the fluoroscope in the early diagnosis of tubercle in the lung. The honor of having first made that important discovery belongs to Professor Bouchard, December, 1896. In all our researches we have carefully examined the state of the pulmonary parenchyma above the effusion, and we now feel in a position to draw the following conclusions: *When the thorax above the effusion is uniformly transparent the prognosis is good, and there is no fear of pulmonary tuberculosis*. It is quite a different thing, however, *when opacities of more or less irregular shape, which do not disappear with deep inspiration, are found above the liquid*. Then it is a question of bacillary infiltration and our prognosis must be guarded."

In this important chapter there are so many valuable diagnostic hints that the student should read it over to refresh the memory just before making his examinations, till experience makes him familiar with all its points. The careful study of the preceding chapter at the same time will discover a great many suggestions affecting both diagnosis and prognosis. The entire field is so thoroughly cleared for the beginner that, with this instruction at hand, there will be neither excuse nor occasion for the *general practitioner* to delay taking advantage of the immense utility of X-rays. It is hoped that the plain directions here set forth for their use will relieve many from the deterrent influence of imaginary difficulties which have little existence in fact.

## CHAPTER XXXVI

### EXAMINATIONS OF THE STOMACH AND ABDOMEN

IN writing up his "cardiameter" McCaskey describes its use for measuring the distance from the incisors to the cardia, and also for defining absolutely the position of the latter by the aid of the X-rays. In the distal end of a soft rubber colon tube is placed a tightly fitted piece of metal tubing, over which is adjusted a small bag of very thin rubber, the end of which projects about an inch beyond the tube. The proximal end is attached to a closed rubber bulb. Compression of the rubber bulb expands the bag, which collapses when the bulb is relaxed. A centimetre scale is placed on the tube, measuring from the distal end. The tube with the rubber bag collapsed is introduced into the stomach and expanded with air by compression of the bulb. It is then withdrawn until the impact of the rubber balloon is felt against the cardiac orifice. Passing the writer's description of its general diagnostic uses, we cite his closing remarks.

"So far my investigations along these lines had been with exclusive reference to the precise distance of the cardia from the incisors with a special reference to the use of intragastric appliances. At this point it occurred to me that by fixing a piece of metal at the cardia and taking a radiograph with suitable surface landmarks made by the shadows of metal, the precise position of the cardia with reference to the surface of the body could be determined. This proved to be entirely feasible, and I present herewith a radiogram demonstrating the result in a case of extreme ptosis. By this means at least one point in the upper border of the stomach can be mapped out on the surface with absolute precision."

**The Gyromele in X-Ray Diagnosis.**—The "Gyromele" is a flexible steel cable, practically a revolving sound, with spiral end provided with a metallic pellet covered with wool, cotton, or sponge, and operated by a revolving drill handle. From an extensive article by Turck, we take sufficient description to explain its *modus operandi* and the particular uses of X-rays.

"The following cavities have been explored successfully with the gyromele: the oesophagus, the stomach, the pylorus, the small in-



testine, colon, bladder, uterus, thoracic cavity, nose, and throat, and false cavities of various characters. After introduction into an accessible cavity of the body the revolving apparatus is put into motion, and the rotation of vibrations caused in varying degree which are transmitted through the tissues, are perceived externally by palpation and auscultation. Cables of different calibre and length have been devised to provide different degrees of flexibility and elasticity, and thus broaden the scope of usefulness of the instrument for different purposes.

"It is not only its extraordinary adaptability, flexibility, and elasticity which enable the instrument to enter cavities hitherto inaccessible, but it is the *rotary motion* which adds greatly to the safety and facility of the device. Since the delicate rotations gently wend their way through any possible narrowing, and these rotations can be followed externally by the ear or the finger, we are enabled to gain valuable information of cavities which were formerly inaccessible. This information is not limited to anatomical data, situation, extension, capacity, and so on, but we may obtain valuable facts as to contents of the cavities, adherent masses of mucus, bacteria, etc., by means of specially constructed terminals. The flexibility of the gyromele is of such a degree as to adapt itself to the situation, shape, and size of the organ explored, particularly the stomach.

"By means of the revolving-drill apparatus, to which the sound is attached, vibrations are produced which can be palpated and ausculted externally, thus giving us exact information of the presence and locations of the revolving table. The situation of the metal sound can also be verified by means of the X-rays. The fluoroscope and the radiograph both give excellent results. By transillumination of the patient with the X-rays it can be clearly observed how the metallic sound makes its way along oesophagus through the stomach and pylorus, and into the small intestine."

After setting forth its important uses in connection with the diagnosis of diseases of the stomach and intestinal tract, Turek thus continues:

"By the use of the X-rays diagnosis by means of the gyromele cable, combined with palpation, is made more certain and easy. The technique of employing it for examination of the stomach is simple. The cable is introduced in almost the same manner as the ordinary stomach-tube. Some experience is required to locate the fundus, greater curvature, pylorus, and lesser curvature, with certainty, but even the inexperienced find the introduction of the thin cable, covered with rubber tube, the thickness of which reaches at most only five or six millimetres, and armed with the soft cotton tampon or sponge, easier than the introduction of the thicker and flabby stomach-tube. This is particularly the case with patients unused to intragastric methods.

"The rotating cable is covered the distance from mouth to cardia with a rubber tube. In this tube, the cable moves freely, and thus little friction is caused. Since this surrounding rubber tube remains stationary, a pushing to and fro of the cable is unnoticed by the patient. As soon as the tampon on the end of the cable has reached the greater curvature, it meets slight resistance, the cable bends, and the end glides along the greater curvature until at the antrum pyloricum, or lesser curvature, it again meets resistance. Now, the stomach is moderately inflated with air and the cable pushed slowly forward; its end now turns—as has been observed by the X-rays—toward the left and upward along the lesser curvature. Thus the cable is seen to describe an irregular circle, influenced by the contour of the stomach. Pushing the cable still farther into the inflated stomach, it will bend into the fundus, there adapting itself to the dome thereof. All of these phenomena can be observed with as much certainty by external palpation and auscultation of the rotating cable end, as with the X-ray. This holds true, even of those parts which are covered by the left lobe of the liver or by the ribs. By following the rotations of the cable end with a skin pencil the contours of the stomach are drawn upon the abdominal surface. The first attempts to observe the introduced sound *in situ*, with the aid of the X-rays, were made in the spring of 1896. The density of the steel sound is seen to interrupt the rays and give a distinct contour of the sound. It is extremely interesting to observe the excursions of the rotating cable with the aid of the X-rays or the entrance of the end of the cable into the pylorus or duodenum. I have often found the borders of the stomach, previously marked by lead roll fastened upon the abdomen, confirmed by transillumination. The ensiform appendix and umbilicus were marked with metal buttons, and their position was also confirmed.

"Measurements were made by graduating the cable with lead shot. All those experienced in the *diagnostique* of the stomach and intestines will readily appreciate the value of this method. It is easily seen, when applying bismuth-salt emulsion, by means of the gyromele, that the walls of the stomach and oesophagus become thoroughly coated with a stratum of the emulsion."

Read also the section on accessory shadows as aids to diagnosis in the chapter on the art of reading X-ray shadows.

**Examination of the Abdomen with X-Rays.**—Blacker has offered the following remarks on this subject:

"It is not always easy to find a bullet within the abdomen, although large and undoubtedly present. That a mass of metal may be embedded within the abdomen without being visible on the fluorescent screen or on the developed film is known to most of us, and the reason for this is that the spent projectile having only sufficient force to penetrate the abdominal wall and to become embedded in



some of the many soft structures which occupy the cavity moves very freely with respiration. The blurring effect of this movement is much greater than any one not accustomed to work with the fluorescent screen would imagine, the length of the shadow thrown depending to a great extent on the distance of the foreign body from the screen, on the movement which takes place during respiration, and on the movement of the intestines in the neighborhood of the bullet.

"We were familiar with the movement which takes place in the abdominal cavity during examination for foreign bodies which have entered through the alimentary canal, or through the abdominal walls, which renders X-ray examination difficult, and failures in examining for renal *calculi* did not therefore appear hard to understand, considering that in addition to this movement search was being made for a substance which (according to its composition and size) might or might not throw a shadow on the sensitive surface. But with a metallic substance, which as a rule gave a dense shadow, it did not at first seem conceivable that the blurring of the shadow caused by the movement would be sufficient to render its discovery difficult and its localization impossible without definite precautions being taken. Such, however, is the case. In the case of all opaque substances it is customary now to examine during one phase of respiration only. This to a certain extent does away with some of the difficulties, but it is difficult even with a mechanical arrangement denoting the position at which the exposure is to be effected at each succeeding respiration, to prevent some blurring of the shadow caused by movement of the abdominal contents; for even if the relative position of the bullet can be made out the exact localization is not easy.

"The chief difficulties which present themselves when examining the abdomen with the X-rays for the localization of a bullet are:

- "1. The distance of the bullet from the screen or film.
- "2. Possible astigmatic action of the tube. (Use a tested tube.)
- "3. Movement of the bullet with the tissues within the abdominal cavity which may be caused by respiratory, or intestinal movements, or by pulsation of vessels.
- "4. Involuntary movements on the part of the patient during exposure.
- "5. Effusion of blood if the case be one of recent origin.
- "6. The presence of dense inflammatory material in old cases.

"In order to obviate as far as possible these difficulties, it is necessary to place the screen or film as near as possible to the supposed position of the bullet, and to direct the rays so that no opaque tissue intervenes between the tube and the bullet, or between the bullet and the screen. The respiratory movements can be controlled to a certain extent. Intestinal movements may be controlled by drugs. Involuntary movements on the part of the patient can always be controlled by an anæsthetic, if not by strapping.

"For the purposes of exact localization there may still be opaque tissues obscuring the shadow which cannot be avoided, such as adipose

tissue, bones, well-developed muscles, pulsation in the neighborhood, and effusion of blood. These remarks apply only to bullets embedded in the movable tissues of the abdominal cavity. Those embedded in a fixed position present no particular difficulty in an X-ray examination."

The intestinal organs are most at rest when there is no food in the stomach and after thorough cleansing of the tract by purgation and enemata. In an important case allow twenty-four hours for this preparation. This applies to both abdominal and pelvic examinations. Still further restriction of movement may be secured by opium; or, without a narcotic, by a thin and tight muslin binder. Complete anæsthesia to secure physiological rest during an exposure will be a last resort and can be employed when indicated. Or, if the patient is being anæsthetized for an operation, the occasion may often be opportune for a quick exposure and rapid revelopment of the plate for the surgeon's guidance. Suitable facilities enable this to be done with practically no interference with the surgical preparations for work.

In our next chapter we will take up the uses of X-rays in therapeutics, a subject which is fast attracting the attention of practitioners, who will find in this section the explicit instructions they require for the treatment of their own patients.



## Studies in X-Ray Therapy

*"Flattering reports from so many workers in this field forces upon us the conviction that a new era in the treatment of certain rebellious diseases of the skin is now opening, and that a new agent has come which will occupy a high place in dermato-therapy. It has been the criticism of many that we have recurrences after this treatment! But is this not so of all other known methods? Can we insure a patient that his epithelioma will not recur after removing it and a wide margin of his integument with the knife? Can we tell him it will not recur after having him spend hours of pain under the arsenical pastes? Can we promise a lupus patient freedom from his disease after months of pastes, caustics, plasters, salves or lotions? These diseases will often recur after any method, and if they do after the X-rays, there is no form of treatment as painless, simple, and easy by which to treat the recurrence. It is particularly applicable to these cases, as the ease of its application relieves the despondent, discouraged and timid patient of all fear of active or painful procedure."*

—(INTER-STATE MEDICAL JOURNAL, December, 1901.)

## CHAPTER XXXVII

### EMPIRICAL NOTES

THE BEGINNINGS OF SCIENTIFIC X-RAY THERAPY. A CHAPTER CONTAINING MUCH VARIED INSTRUCTION AND INFORMATION.

THE faithful reader of current medical literature may recall that many mentions of X-ray therapeutics have floated before his eye, yet when a particular case enlists his interest he is apt to find that scattered abstracts are vague memories without detail. For this reason the review of a selected number in an orderly study will not only enable us to judge how far X-rays may be credited with therapeutic actions, but will suggest hints for personal application in our own cases. We therefore feel that the clinical beginnings of X-ray therapeutics will interest and enlighten a large majority of the profession, and, probably, no chapter in this book will better repay study. Beginning with one of the earliest mentions that we find in print, the remaining abstracts will not attempt a regular chronological order.

"In March, 1896, Schonberg began the treatment of two cases of lupus. The first was a young man who had been treated early in 1895 with scraping, iodoform, cauterization, nitric acid, etc., and in 1896 with tuberculin without results. X-ray therapy was carried out in the following manner: the patient was stretched out on a table and a tin-foil mask put over the entire portion of the face which was not affected by the disease. A cap of tin-foil also covered the head. The tube was ten inches from the face. A coil was used and daily exposures of twenty to thirty minutes were made. In seventeen days, on April 4, 1896, the exposed surface showed a very distinct reaction and redness, and four days later the dermatitis was general. From this moment the ulcerated portions gradually yielded and recovery resulted. In the second case, that of a woman forty-eight years old, the same method was employed with equally satisfactory results.

"Ullmann reported in a German paper a case of severe *acne* of the back in a patient aged sixteen, treated by the X-rays. Fifty exposures of half an hour each were given. After fifteen sittings the acne spots swelled and there was a diffuse erythema of the skin. Afterward the acne spots shrunk, while the skin over them exfoliated.



"Early in 1898 Gautier reported three cases of facial *acne* treated by X-rays, one being as follows, after the failure of many other attempts to cure: A medium Crookes tube was used and enveloped in a black cloth to shut out the electric-light radiations. It was excited with a coil taking in the primary four amperes at twenty volts. The eyebrows, eyelashes, and hair were protected by a cover of flexible lead bent to fit the shape of the skull. The tube was twelve inches distant. Exposures daily for five or six minutes. First one side of the face was treated and then the other. The result began to show itself after six treatments; the skin peeled, the pimples became less red, and the glands less apparent. No accidents or ill-effects occurred during these treatments."

"Dr. Leopold Freund, March 6, 1897, reported the X-ray treatment of a pigmented and hairy *nævus*, reaching from the nape of the neck down almost to the folds of the nates, and extending over the whole back, the sides of the thorax, the shoulders, and the upper half of the right arm. The back was exposed daily for two hours at a distance of four inches from the tube. For ten days no effect was produced, but on the eleventh day the hairs began to fall out in bundles and continued to do so to an increasing extent for eight days, when a slight dermatitis appeared which soon yielded to ichthyol. By this time the neck and inter-scapular space had become quite bald. No new growth had taken place within six weeks. [It is assumed that during the two-hour seances the rays were directed to different areas so as to attack a single part but a short time.—Ed.]

"About a year and a half later Freund and Schiff reported further on two *lupus* cases and seven *epilation* cases. In their cases of epilation they had obtained the best therapeutic result after from seventeen to thirty short exposures. In several cases they noticed that one or two days before the hair fell out the skin showed a brownish discoloration, which disappeared three or four days after the hair fell out. In several brunettes the hair became white before it fell out. The effect of the rays is cumulative. They also state that Jutassy has, since Freund's first publication, treated forty cases of *hypertrichosis* by X-rays, and in some of them there has been no regrowth of hair after a year.

"Dr. Leigh reported a case of a young man with a *bullet in the thigh*. At the time of the examination the knee was very much swollen, exquisitely tender, and painful. The slightest touch or motion made him cry out in agony. Having at that time an imperfect coil and poor tube the surgeon exposed the knee to the X-rays for four hours in the attempt to get a radiograph. Failure delayed the operation. The next day the patient moved about the bed without pain; the second day he was up in a chair, and the third day he was walking about on crutches. A second case was one of *tuberculosis* of the elbow-joint. Professor W. advised excision. Another consultant advised the use of the X-ray. The joint was exposed two and three times a week for two hours at a time till the

total application equalled twelve hours. A wet dressing was applied after each treatment. In a short time all signs of inflammation had disappeared, and now eighteen months have passed without any return of the disease.

"The third case was an examination for *gall-stones*. For several months the patient had been suffering frightful attacks of pain at frequent intervals. No stones were found by the examination, which was prolonged. Since the examination, however, the man has not had an attack and is in perfect health. A third and fourth case of a similar nature were also apparently relieved by the use of the X-ray.

"Dr. G. Cantrie reported the cure of a *varicose ulcer* by exposures to X-rays. Between November 5, 1898, and February 1, 1899, eight exposures were made with the tube ten inches from the surface of the ulcer. The first seance was five minutes, and all following were ten minutes.

"From Germany was reported the cure of a case of 'undoubted *tuberculous peritonitis*' by the X-rays. The patient was a girl aged nine years. Tapping, abdominal section, repeated tapping, and washing out with a creosote solution had negative results. She grew steadily worse, and the tuberculous masses in the abdomen steadily enlarged during treatment. First X-ray exposure was for ten minutes with tube eight inches from the abdomen. Two days later a second exposure of ten minutes was made at five inches. These were repeated for a month at intervals of two or three days. Treatment was then stopped for a month for extraneous reasons, but the patient returned and was treated another month. By the end of two months net treatment there was absolutely no abdominal effusion. From this time she gained steadily in weight and strength till she became apparently well. No dermatitis appeared. There was a slight pigmentation of the skin of the exposed region which could still be seen three months after treatment ceased.

"Jutassy reported in August, 1900, the following cases treated by X-rays:

"1. *Lupus vulgaris* in a woman aged twenty-four. Exposed the part to an intense current at seven sittings, with a total duration of four hours. The patch of lupus became a bleeding raw surface, which healed under antiseptic dressings in a month and formed a smooth scar.

"2. *Lupus erythematosus* of the nose and face in a woman aged twenty-eight; duration of disease eight years; seven treatments were given, having a total of five and one-half hours exposure. The central skin of the diseased area came off in a thick layer. A second series of six exposures with a total duration of three hours. Soon after this the surface of the lesion desquamated, and the face was clear and remained so for eighteen months, when there were some small recurrences.

"3. Chronic *eczema* in the hand of a man aged twenty-nine;



duration of disease eight years; eight exposures were made, with a total of two and one-half hours. A crust formed on the affected skin, this healed and left the skin healthy.

"4. *Hypertrichosis* of the face and neck in a man aged twenty-five; ten sittings were given, with a total exposure of three and one-half hours. Two weeks afterward the brownish erythema appeared and the hairs were completely shed. Two months later new hairs grew at the angle of the mouth and a second series of sittings was given, combined with electrolysis of some of the larger hairs. A good result was obtained.

"5. *Port wine mark* in a man aged twenty-two; ten sittings were given, aggregating fourteen hours exposure; the eyebrows, upper lip, and eyelids being protected. A pustular dermatitis resulted which healed under simple dressings. Three months later the naevus had disappeared and was replaced by a smooth whitish scar. Unfortunately pigmentation appeared at the edge which resisted all treatment.

"6. Treatment of a *Port Wine Mark* upon the face by X-rays.

"The patient was a man aged twenty-one. The mark covered the whole of the right side of the face and involved the mucous membrane of the mouth and nose. A small portion of the middle of the cheek was experimented on at first, the rest of the head and face being protected by a lead mask. Exposure was continued till a strip of sound skin showed a slight degree of hyperæmia. Ten days later this strip became deeply pigmented. One month later it was noted that the exposed portion of the naevus was distinctly paler than the rest. Treatment was then begun again, and a much larger surface was exposed till a definite erythema was produced a second time. On this occasion the epidermis was completely detached, and the corium beneath was exposed. The sore left was about two months in healing. At the end of that time the result was phenomenal. The naevus had gone. In its place was a smooth, soft scar, if a rose-red patch of skin can be called a scar. Only at the edge was a little brownish pigmentation. A year and a half later the greater part of the skin was nearly normal, and the mucous membrane on the nose was much paler. In winter the color of the skin becomes a little deeper, but this is only temporary."

"*Neuralgia* treated by X-rays. Stembo was led to make use of this method for the purpose of relieving neuralgic pains by the fact that sometimes patients report relief from pain when the rays have been employed for merely diagnostic purposes. A coil giving a twelve- to eighteen-inch spark was used, the rate of interruption being about 1,500 per minute. The distance of the anode varied from eight to twenty inches from the part affected. If the part was comparatively insensitive or the pain deeply seated the patient was insulated, but not otherwise. If the face was affected the skin over the part which was not painful was protected with tin-foil. Sittings were from three to ten minutes, and every second day. Relief was

generally reported after the third application. To derive benefit the electrostatic field must be strong enough to cause a slight pricking sensation when the patient is touched by the operator."

"Dr. Hahn before the medical society of Hamburg in November, 1900, stated that there was an increasing interest in the treatment of skin diseases by the use of the X-ray; and introduced for their examination some of the patients who had been so treated. He placed lupus in the foreground of interest. He also claimed to have treated with good results eczema, psoriasis vulgaris, lupus erythematosus, rosacea, favus, sycosis, and hypertrichosis. He stated that 'it goes without saying' that the treatment is alike beneficial for both acute and chronic eczema. The doctor presented a case of eczema in a young lady of seventeen who had suffered from it in malignant form since earliest childhood, satisfactorily proving a complete cure as the result of the X-ray treatments. These diseases respond quickly to the Roentgen rays, particularly in the suppression after one or two treatments of the itching that is the accompaniment of eczema. Psoriasis cases were equally benefited by the X-ray treatment, the scales dropping off at from four to six exposures without the characteristic bleeding. Of lupus erythematosus he reported three cases. Of these two cases were positively cured; of the third he could only report apparent good results while treatment was continued, but the patient went away and the case was lost sight of.

"In two cases of rosacea, the cures were at least long-lasting, if not complete, as there had been so far no return of efflorescence upon the skin. In cases of reddening of the nose, the X-ray seemed to destroy the germs at once. He said the triumphs of the X-ray treatment have been marked in all diseases of the skin which, as a rule, accompany hair diseases, remarking that to cure the first it was necessary to remove the hair. Speaking at length, he remarked, that in the two cases of favus mentioned, compared with cases otherwise treated, the preference was decidedly in favor of the X-ray. In a case of sycosis, in which positive cure was effected by the X-ray treatment, the doctor stated, that after a few exposures the swellings the size of walnuts fell off, the hair disappeared, and the inflammation went back, the affection disappearing with the healing of the slight burning caused by the X-ray. In the cases of sycosis mentioned excellent results followed, though they had been persistent for from two to twenty years. In the specially demonstrated case, the affection had been existing for six years. The hairs were sticking in the inflamed follicles on both cheeks, chin, and upper lip; the main parts between were red and infiltrated. After twenty-three treatments with the X-ray an excoriation of the chin about the size of a nickel appeared, but quickly yielded to emollients applied. After the cure of the excoriation, the chin and cheeks appeared in an entirely normal state, though the upper lip remained slightly reddened. The results are unfailing and cure can be guaranteed. In the growth of hair, which occurs in from two to four months, the recurrence be-



comes less and less, until finally they will not grow again; the skin stays smooth and no scars or observable change appears."

As Schiff and Freund of Vienna have been two of the most prominent pioneers in connection with X-Ray Therapeutics, it will be instructive to study the conclusions of their report in August, 1900, after more than four years' experience.

"The influence of the X-rays on the skin consists first in a relaxing effect on the deep vessels of the corium, and an effect with which is certainly associated a slight exudation into the tissues of the epidermis and cuticle. This process causes a swelling of the hair papilla on hairy parts of the body, and, consequently, also a detachment of the hair bulbs. In cutaneous affections with inflammatory infiltration and new growth of young tissue the cellular formative elements get altered in their molecular composition and thus prepared for absorption. Whether the X-rays act injuriously on micro-organisms, or whether it is only that phagocytosis, becoming more pronounced under the inflammation, proves serviceable in parasitic affections of the skin, has not yet been determined even after four years of research. Among indications which call for treatment with X-rays may be enumerated abnormal growth of hair, and all cutaneous diseases caused or prolonged by the presence of hair, as sycosis, favus, wounds of the hairy parts of the body, and trichorrhexis nodosa; and as furunculosis, acne, lupus vulgaris, lupus erythematodes, eczema, and elephantiasis.

"The method is very simple. *The tube at six inches from the skin is so placed that the anode stands exactly opposite and parallel to the irradiated field.* Sitzings are daily held; at first five, and, later on, ten or twenty minutes. The distance of the tube may also be slightly and gradually lessened. The parts not diseased are protected with a sheet of card-board covered with lead-foil one-fifteenth of an inch in thickness in which holes are cut to fit the diseased area. As these 'leaden masks' may be used by several patients, or more than once by the same patient, they are lined with card-board, which is alone in contact with the tissues and which can be thrown away after each sitting. *As soon as the skin appears turgid, or shows a pale pink or brownish tint, or when, at the place in question, the hair becomes loose, then the irradiation of this part must be stopped.* This occurs after from seventeen to twenty-five sittings, with hypertrichosis, and after seven to ten sittings with sycosis and favus.

"In a case of general growth of hair on the face, it is of advantage to treat both cheeks at the same time, and after these have been depilated, to treat the chin. Occasionally, there are disagreeable occurrences, such as slight conjunctivitis, pruritus, and erythema. Conjunctivitis may be avoided by the use of lead masks, or by advising the patient to close the eyes during the sittings. For treatment of the conjunctivitis the usual astringent eye-wash proves effective. For

the erythema and itching the fifteen per cent. boric lanoline acted on all occasions as an excellent remedy. Both of these symptoms, as well as conjunctivitis and the slight bronzing of the skin to which many women are averse, disappear spontaneously in two or three days. In the case of lupus the irritation may be more intense, and one need not be afraid of the appearance of slight dermatitis. As we have already stated the affection proceeds by imperceptible stages toward cicatrization. The scars, moreover, are very tender, and resemble the normal skin. Quite striking, too, is the improvement that takes place under this treatment in the *complexion* disfigured by scars, pustules, and comedones, and this may be due to the circumstance that in the uppermost layers of the skin a small exudation stretches the epidermis, and therefore removes elevations and depressions.

"With this treatment, however, the cure is not yet completed. Hypertrichosis, especially, still needs for its radical removal a long after-treatment, consisting of three to five short sittings at intervals of from four to eight weeks for about a year. Should this after-treatment be neglected, the hair at the depilated places will, in by far the majority of cases, begin to grow again in about two and a half months. Only in a few cases did the first course of treatment suffice to accomplish a radical cure. I would here call attention to the fact that the results of the ingenious Finsen Method of treatment by rays of light correspond to those obtained with X-rays, as regards lupus. It should be noted, however, that the Finsen treatment seems suitable only for smaller lupus patches, whereas the X-ray is preferable for large areas."

Small currents were used by these authors. The direct current used to excite the primary of the coil was usually twelve volts and one and one-half amperes. They attributed the absence of all accidents and ill effects during treatment to the use of these relatively small currents. Trials made in a large number of patients justify the statement that henceforth a radical cure of the above-mentioned diseases can be assured. The cure of favus and sycosis requires but a few weeks, while hypertrichosis requires a very long period. The duration of the treatment of lupus depends upon the extent of the disease. A large number of modifications which the skin undergoes during the influence of the rays are due to the effect of the rays on the vascular system of the skin as Kaposi has stated. It is now certain that in treating skin diseases with X-rays the silent discharges of the high-tension current play a considerable part. Freund has studied the physiological effect of direct sparks, silent discharges, and other invisible radiations, and arrived at the following conclusions:

"Direct sparks, whatever be their origin—whether direct discharges from an induction coil, or silent discharges from the d'Asonval-Oudin high-frequency apparatus may cause the hairs of animals



to fall out. Direct sparks can destroy both recent and full-grown cultures of bacteria or arrest their growth. Experiments have been made on staphylococcus, pyogenes aureus, bacillus typhosus, those of diphtheria, anthrax, tuberculosis, the fungus of Soor, and the achorion of Schönlein. This action of direct sparks is increased by grounding the patient, by bringing the electrode near, by more rapid interruptions, and by increasing the primary current. These effects are produced even through thin layers of wood, paper, aluminum, tin-foil, and skin. The action is extended to micro-organisms suspended in liquids. Negative discharges produce greater physiological effects than positive, but over a smaller area. According to these experiments the X-rays have no physiological importance apart from electrical action.

"Pathological effects produced in the skin by direct electric discharges consist of alterations in the vascular system, irritation, inflammation, and hemorrhages into the dermis. In the discussion M. Oudin recalled the experiments performed at St. Lazare on the action of X-rays on the nutrition of hairs, and pointed out the great difference he has observed in different subjects under the same experimental condition. In the clinical cases of M. Bernard epilation was produced under the hole in the sheet of aluminum, but not under the sheet itself. M. Restot was of the opinion that the effects attributed to X-rays on the vasomotor system must be referred to an action on the peripheral nerves. M. Bouchacourt said that, whenever he observed accidents or sensations in the numerous experiments with which, since the discovery of X-rays he had been ceaselessly occupied, he has attributed them not to the rays themselves, but to purely electrical emanations proceeding from the apparatus. M. Bergonie remarked that, so far as his own experience went, whenever he used a tube of low resistance around which no electrostatic field was produced he has never produced either accidents to the skin or falling of the hairs in spite of long exposures. On the other hand, with a high-resistance tube from which there was a discharge to the surrounding objects, and, therefore, also to the patient, he has observed slight erythema, and the efficiency of the tube is also diminished for radiographic and fluoroscopic work. *'A tube which will make a good radiograph with marked contrasts does not injure the skin however long the exposure,\* whereas a discharge which produces a bad radiograph with poor contrasts gives rise to more or less marked alterations of the skin.'*

"In closing, M. Schiff stated that the action upon hairs depends upon the duration and intensity of exposures. Aluminum had not appeared to him a sufficiently protective metal, while leaden masks have given him complete satisfaction. Lastly, he agrees with all who think that the curative actions he has observed are due not to

\* This statement must be restricted by readers to refer to skilled regulation of distance and normal time, for it is absolutely certain that exposures at too close range and for a duration beyond safe therapeutics can cause dermatitis even with such a tube, or any tube. Distance and dosage of current must be properly regulated as well as exposure-time.—AUTHOR.

the rays themselves, but to the electrical conditions that accompany their production."

In a note on the X-rays as a curative agent in certain diseases of the skin Williams states it is his experience that it is *not necessary to produce an inflammatory reaction*. This is also his opinion in the treatment of lupus, in cases of which he "has demonstrated the accuracy of this conclusion." Dermatologists may read the next excerpt with care.

"The problem of utilizing these properties of X-rays for therapeutic purposes has involved not only the determination of the effects of X-rays upon tissues of various sorts, healthy and diseased, but the determination of the conditions under which the desired results might be attained within the limits of safety. A number of experimenters have engaged in clearing up these questions. The results which have been attained by various workers in establishing the conditions of safety of the use of X-rays for diagnostic purposes have furnished many of the data which have been utilized in working out the problems of the use of X-rays for therapeutic purposes. The advantages which this method seems to offer for the treatment of lupus may be briefly summarized as follows:

"1. Efficacy: Practically all of the cases which have been treated by this method have been of grave, persistent character, and had resisted recognized forms of treatment for years. The diagnosis in practically all of the cases is above question.

"2. Freedom from pain: When one remembers the various other plans of treatment, with the never-ending repetition of painful procedures in the severe cases, such as those in which this method has been used, the fact that this method is practically painless appears as an advantage of no small consideration.

"3. The character of the scars: All observers agree upon the excellent character of the scars following this method of treatment. They are soft, pliable, and thin, and nearly approach the normal skin in appearance.

"The removal of hair by this method is attended by no disagreeable sensations and by no accompanying symptoms beyond at times a slight erythema or pigmentation, lasting a short time. The skin, after removal of the hair, is left in the same condition as before, except for the absence of hair. There seems every reason to believe that in X-rays we have an agent of the utmost value for the removal of hair. It is painless, not nearly so tedious as electrolysis, and can be applied to the hairs of a large surface at one time. When there are only a few large hairs to be removed electrolysis will still be probably the more convenient method, but there is no comparison in convenience between the two methods for taking off a large number of hairs from any given area. For instance, all of the hairs from the back of the forearm can be removed together. The method is par-



ticularly adapted to cases in which it is desired to remove down and profuse growth of hair.

"The mycotic diseases of the hair and hair follicles, such as tinea tonsurans, favus, and sycosis are among the most intractable diseases that the dermatologist is called upon to treat. The difficulty is in getting at the peccant organisms. In practically all methods of treatment of these affections the first essential is thorough epilation. But thorough epilation is easier said than done, for, leaving out of consideration the pain and tediousness of it, the difficulty of epilation by mechanical means is that in the diseases where it is indicated the hairs become fragile, or so macerated and weak that in the attempts at epilation they break off, leaving in the follicles the diseased bulbs and broken hair shafts, filled with the organisms almost out of reach of one's remedies. In the treatment with X-rays this difficulty seems to be overcome in an ideal way. The hairs become loose and are removable without force. It is probable too that the effects of X-rays are not limited to their depilatory properties. In sycosis in particular the method has proven successful.

"It is conceivable that this method could be applied in all conditions where epilation is needed. It has been applied with success by Gocht, in wounds of the scalp in which healing was prevented by growth of hair into the wounds. It has not, so far as I know, been applied for the removal of hairs in trichiasis or for the removal of hairs for any purpose about the eyelids." (PUSEY.)

Especially interesting are the following observations of recent date:

"The hard tube, I think, offers the best results. We get a steady stream of rays and an excellent result if the exposure is not too long. If it is too long you will probably get a sore. A lady who came from Germany showed me her arm, which had been exposed for half-hours daily for a month. It had a sore which had not healed for two months, and had left the tissues hard. With regard to different diseases I have the pleasure of bringing some of my cases here to-night. Two of them were examples of very bad rodent ulcer. I commenced treatment on one of them about June 18th. The ulcer at that time extended over the forehead into the corner of the eye. He has had twenty-five applications of fourteen minutes each at irregular intervals, with the result you see to-night, and I think it is sufficiently encouraging for me to go on. In the course of twenty-five years' practice I have never seen anything which has given such capital results in so short a period. The other case, in which there was an ulcer all over the top of the head, has equally improved. He has not been regularly treated, but results are going on equally well. In my third case the disease appears to have dried up.

"I have been making several experiments on ringworm and alopecia. I had a very bad case of alopecia in which I made one exposure of fifteen minutes. The next time the patient came the patch

was larger and looked worse. In about two weeks more he came back, and his hair was growing beautifully." (DR. STARTIN.)

"So far as I can judge Dr. Sharpe considers treatment for certain skin diseases with X-rays and high-frequency currents about the same. Personally, I get more success, and, with shorter treatment, by using high-frequency currents, not only locally, but generally. With regard to the disputed action of X-rays or high-frequency on bacteria I may say that you cannot kill them directly, *but you can grow them to death*. When they get to the fifteenth or the sixteenth generation, they are not worth calling bacteria—they have grown themselves out of existence." (DR. CHISHOLM WILLIAMS.)

"I agree with the contention that the therapeutic effects of X-rays in various skin diseases *are best attained without dermatitis*. At the London Hospital some thousands of applications of X-rays have been made in cases of rodent ulcer and lupus during the last eighteen months without the occurrence of a single case of dermatitis. *Hard tubes* alone were used. Dr. Sharpe has compared the effects of X-rays upon the skin with those produced by the chemical rays of light with Finsen's apparatus, and suggested that the same agent was at work. I cannot agree with this, as the effects are so very different. Those of the chemical light rays are seen in from six to twelve hours after the exposure. The skin becomes red and swollen, and sometimes vesicles form. These heal with great rapidity under a simple dressing. Again, there is no doubt that the chemical rays possess very active germicidal properties, while the evidence in favor of such properties in X-rays is very conflicting." (DR. SEQUIRA.)

"I find rodent ulcer much more amenable to the X-rays than lupus, and have had some remarkable results. They have all been bad cases of advanced disease. In some the Finsen method had been tried and had done little good, chiefly, perhaps, owing to the difficulty of applying the compressors. My method of treatment is always the same. I work with a tube taking a spark of about six inches, the anode about six inches from the face, and the exciting current about six amperes. The face is covered, except the diseased portion, with a mask made of an old handkerchief covered with lead-foil. Treatment goes on steadily day by day, ten minutes at a time. *I have not had any reaction troubles*. The one lupus case which I have treated seemed to do best when exposed seven or eight times to a low-resistance tube, after which a slight reaction occurred. With fairly high tubes we went on without any reaction." (DR. LOW.)

"A consideration of the effects of X-rays upon tissues does not leave us altogether in the dark as to the reason for these results. The condition of tissues affected by X-rays has been studied histologically by several observers; among others by Gilchrist and Kibbe in cases of X-ray dermatitis, and by Oudin, Barthelémy and Darier, in X-ray baldness. These observers agree that the most marked changes are found in the epithelial structures. The growth of the epidermis is influenced in a remarkable way. There is great increase in the



thickness of all of the layers of the epidermis, particularly of the mucous layer, increase in the amount of keratohyaline and pigment, and evidences of greatly increased karyokinetic activity, all going to show that there is marked stimulation of the activity of cells. The studies made by Oudin, Barthelémy, and Darier—in which the histologic studies were presumably made by Darier—were made upon guinea-pigs in which baldness *without dermatitis* had been produced; and the findings are particularly interesting. Histologically the tissues showed:

"1. Enormous thickening of the epidermis in all its layers.

"2. Atrophy of the hair follicles, which in places had entirely disappeared.

"They conclude: 'The thickening of the epidermis in all of its layers, the increase of keratohyaline, and the quite extraordinary atrophy of the follicles may be viewed as a reaction against an irritant of unusual strength. This irritant appears to increase the vitality of the least differentiated skin elements while the differentiated elements, hair, nails, and glands undergo retrogressive changes and atrophy. Of the hair follicles only traces remain, one or at most three in a microscopic field, and these are no longer follicles, but only conical prolongations of epidermis which dip down seemingly only half so deep as normal follicles. Of hair papilla, or regeneration bulb, every trace is lacking.' *Bearing these observations in mind the statement that permanent removal of hair may be caused by exposure to X-rays loses some of its startling character.*

"The changes in the corium are those of an ordinary inflammatory process without peculiar features—to quote Kibbe: 'Capillary dilatation, with collection of round cells scattered through its (the corium's) structure, particularly around the hair follicles.' There is, therefore, little suggestive of the explanation of the effects of X-rays upon diseased conditions of the connective-tissue structures of the skin, in the histology of X-ray dermatitis, as far as it has been studied. An analysis of the clinical phenomena does, however, throw some light on the subject. In the first place, as regards the hair follicles, Kibbe has made the interesting observation, which I am able to confirm as regards X-ray erythemas, that in the development of an X-ray dermatitis the erythema is seen, under a hand lens, to develop first as a 'punctate redness due to hyperæmia around the hair follicles.' In sycosis under treatment with X-rays, inflammation first shows around the hair-follicles, and, I may add, if the exposures are rightly managed, the inflammation may be confined to the perifollicular tissue. In other words, the hair-follicles and their connective-tissue envelopes are particularly sensitive and react first to the irritation of X-rays. This is more than ever the case if the follicles are already the seat of disease. To this extent, and to this extent only, X-rays may be said to have a selective action on the hair-follicles in inflammatory affections, like sycosis and tinea tonsurans.

"Much the same may be said in regard to its effect in lupus. If

a patch of lupus is put under the influence of X-ray exposures the lupus nodules become reddened and inflamed before, or even without the surrounding healthy tissues being affected at any time. Foci of disease so small as to be imperceptible before treatment become inflamed, reddened up, and become visible. If the exposures are persisted in, the lupus nodules will break down and be destroyed before the surrounding tissue is severely affected. In other words, the specific tissue of the lupus nodules is *of such low vitality that the influence of X-rays may cause its absorption or even destruction before having any considerable effect upon healthy tissue.* And thus far the rays may be said to have a selective action on lupus.

"The practical problem which has to be solved in applying X-rays to the treatment of skin diseases is to so manage the rays as to attain effects sufficient for therapeutic purposes, without overstepping the limits of safety and producing undesirable results. This problem is easier now than it would have appeared three years ago. The evidences that the exposures have been carried far enough are: The appearance of erythema or pigmentation. Blanching of the hair. Loosening of the hair. In the treatment of hypertrichosis the method is pursued with great caution to avoid irritation. In the treatment of inflammatory affections less care is taken. It is not found necessary in the treatment of any of the diseases to carry the irritation to a painful degree." (PUSEY.)

**Action of X-Rays.**—At first many deemed an inflammatory reaction requisite for curative action, but it soon became evident that if irritation was the curative factor we have simpler means of setting it up. Men without adequate experience with related agents have written theories, and have laid down rules that will perplex the novice for some years—till they happily get out of print. But enlightened experience has now settled, at least empirically, the present view of the case as follows:

A dosage rich in rays is desirable. The tube is a vacuum electrode related to those becoming familiar with High-Frequency therapeutics. The best dosage of X-rays is obtained when a fat electric current excites a tube which is neither low nor high, but within the range of medium vacuum which will best develop the bombardment of the given current and transform it into the most abundant quantity of rays. The therapeutic action of this electrical discharge is allied in nature to that of the ultra-violet field of electric-light, to the similar spray from a large Static machine with a suitable electrode, and to the High-Frequency spray—all products of electricity and all producing similar effects in skilled hands. Men acquainted with but one of these discharges may be surprised at their similarity.

The curative action of a substitutive inflammation in certain



cases is not denied, but it is denied by the best authorities that *dermatitis* is *X-ray therapy*. The true curative effects of X-rays are obtained in all cases without the need of setting up any dermatitis, and, if the latter occurs, it is a fault of method and a drawback rather than a help. Some still cling to the older opinion, but the fact that leaders get better results without dermatitis proves their case.

Given an *efficient* electric current and tube, it matters not what *type* the current may be. An alternating, direct, or Static machine current will do the work if the accessories are suited. Some have asserted the need of small currents with coils, but later experience proves that if the tube and technic is adapted to the work a large current is vastly more efficient and shortens the treatment more than half, without ill-effects that were formerly feared. The present tendency is to look for shorter exposures and quicker results through the aid of increased efficiency in radiance—larger currents and the avoidance of low, and hence feeble, tubes. Large and well-equipped Static machines giving thick currents are particularly suited to X-ray therapy. There are several thousand Static machines in use in X-ray treatment as well as in X-ray diagnosis, and many claim superiority for them. The author does not wish to take a partisan side, and he is well aware that many Static machines are too small in size to produce an efficient current that would satisfy the trained expert, but, granted an energetic and well-made machine giving the thick current that only sixteen to twenty-four revolving plates of thirty or more inches in diameter can generate, the facts are as follows:

1. The greater the quantity of light the better, and the maximum produced under skilled control is *perfectly safe for the tissues at a proper distance*.
2. It is exceedingly easy to avoid dermatitis with tubes excited by static currents. With fair precautions they are safe. Avoid too long exposures at too short a distance.
3. It is well-known that static electricity is least liable to dangerous accidents either to patients or to apparatus.
4. Its *remarkable adjustability* permits complete dose regulation to suit any state of the tissues. A medium tube can be run up and down the widest possible range of radiance. It is the most flexible current known, as respects manipulation of X-ray tubes—granted skill on the part of the operator.
5. The author's X-ray gauge furnishes the means of definite measurement of the radiance and meets the objections of those who judge a Static machine by the mechanism of a coil.

6. Much of the best work in all kinds of X-ray therapeutics has been done with the Static machine, as reports show.

During the past five years the author has been many times misquoted in respect to "burns" from Static machines. Many have appeared to find delight in pointing out his supposed error in stating that a static current will never cause an X-ray burn. But he never said so. None of his writings say so. Before our first book was in press there were reports of burns by Static machines and we were aware of them. All who quote me omit my *qualifying remark* that the Static machine in exposures for radiographic work will not burn if a properly dosed current and a proper radiographic method are employed. This has been our view in the past and is still the fact. Abuse is possible, and alterations of the direct static current can transform it so as to be removed from within our proviso, but it is certain that we can regulate the current and tube and adjust the technic for a radiograph so safely that the patient would not be burned even by "nightfall of a long summer's day." Those who pervert these facts assume that there is no difference between a method which seeks to *avoid* ill-effects and one which *invites* them. Not a single statement of ours in the past can be better demonstrated to-day than what we have said about X-ray burns and static electricity. But we have not said some things which have been alleged. What we have written on the subject is capable of *demonstration*, and no one has yet confronted us with disproof, while, on the contrary, we have repeatedly demonstrated the accuracy of our statements to students.

The action of the rays on the tissues is *cumulative* if treatments follow each other before effects subside, and this is desired up to the point of sufficient therapeutic action. Beyond this point control and limitation of effect simply requires stopping the treatment till results mature. Therefore, the interval between treatments is an important factor in the dosage. With a tube excited by a fat current and yielding a rich stream of X-rays, about all the present therapeutic demands for the treatment of practically all lesions are met by a single technic and simple principles of dose regulation. These are about as follows:

1. Protect the surrounding field so that the rays will reach only the diseased tissues.
2. Clear away any possible hindrance to the free penetration of the rays as they do not exert active therapeutic energy through much resistance. Use no opaque dusting powders on the lesion while applying X-rays. The production of a local anæmia assists action, but is seldom necessary.
3. Place the diseased field square with the path of the rays and



centre the focus the same as for a correct radiograph. The main action is in the axis of the rays. Slanting rays are less effective. The sun's rays act in the same manner, as all know who compare early morning rays with vertical rays in summer.

4. Place the tube so that the wall is four to six inches from the surface of the tissues. With modern large tubes from five to eight inches in diameter this removes the anode of the tube about ten inches from the skin, and this is safe under proper dosage.

5. Begin with an exposure of five minutes daily for three days, for a single area. If more than one area requires treatment pose separately and expose each five minutes. Do not forget to connect a grounding wire to the metallic shield used to protect the normal tissues from the rays. After three treatments continue three times a week until some effect of over-action suggests a temporary stop, or till sufficient curative action has been accomplished to suggest an interval to let the results mature before further treatment. In either case resume exposures as indicated, and, after again watching effects, again stop when it seems wise. In this way conduct the case to a termination in recovery, or the nearest possible approach to it. After some experience with the given case the tolerance of the tissues will be ascertained, and exposure-time can be increased as judgment indicates. For all but the trained expert a limit of ten minutes may be adopted as a prudent duration of treatment with efficient apparatus. This is equal to more than a half-hour of early methods with low tubes.

6. The first sign of irritation from X-rays is much like the first sign of sun-burn. The skin shows a little redness and heat or itching. Whenever this is noticed stop treatment till it subsides, which takes but a few days if there has been no improper excess of treatment. The slow-healing, deep injuries of the era of unregulated dosage and wild methods do not belong to X-ray therapy as taught by the present author, and need not be considered here. No careful student of this work will ever see them again. The bicarbonate of soda solution or emollient ointments mentioned under "burns" will quickly correct the mild erythema that is our warning to halt in rational treatment. A cooling sedative static breeze with positive insulation is remarkably effective in incipient irritation.

7. The next important point is how long to continue treatment. In all lesions liable to a relapse do not stop with the healing over of the surface, or, in a case of depilation, with the first falling out of the hair. Recurrences have been the result of too early cessation of treatment. Be governed by the observed effects till surface indi-

cations seem to have been met, but to give permanency to the results give such further treatment at increasing intervals as the history of cases in the hands of experts shows is necessary to prevent relapse. This varies according to the nature of the lesion, but ordinary medical judgment will guide the operator to whom the principles as above are explained. Read carefully the reports of others and note results.

8. Assist results in every case by such adjunct treatment as may be suggested by special indications. Not only drugs, surgical methods, and, in certain cases (as large external cancers) a preliminary operation, may be required by patients in co-operation with X-rays, but we also have in the great resources of modern scientific electrotherapeutics a means of efficiently helping the rays. Do not forget this. Every X-ray operator should read up the whole subject of medical electricity.

9. Do not begin with one tube and use it continuously with a series of cases. Long daily tax upon it will soon increase its resistance too much. Have at least three tubes and use them in rotation. This gives each of them a rest, and with care such tubes will last an exceedingly long time. Also make it a rule to run a tube with just enough current, but never more than is needed in work. No other tax cuts down the life of a tube so much as an excess of current. Many neglect this simple precaution. When much work is done an increased number of tubes to permit rotation and rest is an economy.

In discussing tubes for X-ray therapy—and there has been much undigested controversy as between "hard" and "soft" tubes—the author of a large treatise, published in 1901, stated: "There is no wholly satisfactory way known at present of measuring the intensity and quality of light obtained by one physician with one apparatus, as compared with that obtained by another with a different apparatus. It seems advisable to call attention to the inadequacy of the data given by various writers, as otherwise it might appear incomprehensible that the same results do not follow when apparently the same quality of apparatus was used." It seems to me that my Penetration Gauge described in this volume serves the purpose, and will report a measurement which covers intensity and quality in such a way that all varieties of electrical apparatus are at once brought to a common gauge. Having been using the principle in instructing students since September, 1896, I hardly think there is any doubt about the validity of my gauge as a true measure of X-radiance, such as other authors regularly say is "not known." Those who test the gauge regard it as demonstrating its efficiency.

To complete the instruction contained in the foregoing items of



world-wide observation during the experimental period of X-ray therapeutics we cannot do better than review in orderly survey the striking features of this remarkable development. We cease to wonder at work we daily see, but if we put back the *materia medica* six years and then consider how we shall accomplish some of the results now granted to patients by electrical X-ray discharges we promptly confront a barrier that in important spots proves insurmountable. As time matures our electrical technics appreciation of the scientific therapy which is destined to be built upon the empirical foundations here recorded will spread throughout the profession till all practitioners seize its benefits. To the following chapter especial attention is invited.

## CHAPTER XXXVIII

### X-RAY THERAPY IN SKIN DISEASES

A CHAPTER OF WIDE SCOPE FOR CAREFUL STUDY. A VALUABLE RESUMÉ OF EXPERIENCE WITH CASES AND METHODS. HINTS FROM PRACTICE.

OF more than 200 important X-ray monographs prior to this date a large number have reported upon the actions and results of this agent in cutaneous medicine. An increasing value is recognized. Technics improve. Dosage is better regulated. Certainty is replacing experiment. Exposures are shortened. Frequency lessened. Ill-effects are avoided. Dermatitis is proved unnecessary. Coils and Static machines when of similar current-value are equally efficient. Tubes are standardized. Methods are ready for general professional acceptance. In this important chapter we present the individual experience of an able practical worker whose labors deserve study. Without a specialist's knowledge of skin diseases, without prior experience in X-ray work, but with ten years' experience in electrotherapeutics and impressed by Kümmell's report on lupus, the first attempts of Dr. Sharpe will teach other beginners a great deal of indications and methods.\*

"In February, 1899, a girl aged twenty-one was sent me who had been many years under treatment for *lupus*. She had large scars on both arms and one over the right temple where the disease had been surgically treated, and the disease was reappearing on her face. There was a patch consisting of several nodules covering the whole tip of the nose including the front of the septum; the mucous membrane of the left nostril was extensively involved, impeding the passage of air, and there was some ulceration. Inside the mouth the disease had attacked the uvula and the right faucial pillar, the hard palate, and the gums. The disease had been apparent in the nostril for three years, but had only been noticed on the skin about one year. It was not a good case for a first experience, as I did not see how I was going to get the rays anywhere near the throat, and all

\* Cited with the kind permission of Rebman, Ltd., from Archives of the Roentgen Ray, London.



operators, as far as I then knew, were agreed in saying that mucous membranes were not affected by the treatment. However, the nose offered a fair field, and I started on that, adhering as closely as possible to the orthodox technique. Treatment was begun on February 22d.

"The patient was placed on her back on a couch, her face protected by a paper mask covered with tin-foil in which a hole had been cut for the nose to come through. The tube was fixed in a position over the face so that the rays should fall perpendicularly on the diseased part. The cases were taken to a laboratory where a twenty-inch coil was available, as at that time I had not got a coil in my own house. I was using a Static machine to excite my tubes, and as the therapeutic effects of rays so produced were not known to me I did not like to run any risk of failure with my first cases. *A large tube with a bulb five inches in diameter and low vacuum was used. The coil was worked at twenty volts with an average primary current of five amperes. A mercury interrupter, worked at six volts, gave 250 interruptions per minute. The anode was five inches from the patient's nose. Daily applications were made, lasting from twelve to fifteen minutes.* After the first four treatments the skin became slightly red and sore to the touch, the nodules appeared to stand out more distinctly and to insulate themselves; red scabs made their appearance, which gradually dropped, leaving a red tender-looking spot behind. This peeling process went on until at last no more scabs formed and the skin was soft and smooth. The peculiar effect of insulation of the nodules seems always to take place, and has been described by other observers; nodules show themselves which have not been apparent before. None of the nodules ulcerated, but all the area acted upon became slightly cedematous, and that and the redness remained for some time after the treatment had been stopped.

"After twenty-four applications all the nodules had disappeared, the mucous membrane of the nostril seemed perfectly healthy, and there was no obstruction to the breathing. I was agreeably surprised to get such a good result in the nostril, as all other operators had then reported complete or partial failures with mucous membranes. I next turned my attention to the throat and tried to direct the rays by means of a metal tube which the patient held in the mouth. The throat certainly got better in that the congestion greatly diminished, but the disease at the time did not appear to be seriously affected. I might have accomplished more could I have kept her longer under treatment, but her home was in the country, and I had to let her go. She was under treatment three months; not long enough to insure thoroughness of action, but *eight months later I learned that the throat and mouth were well.*

"For a short time during the treatment of this case I exposed the old scar on the temple to the influence of the tube, and it improved in appearance to a remarkable degree. It became more vascular, the skin softer and moister, and it was altogether much less noticeable.

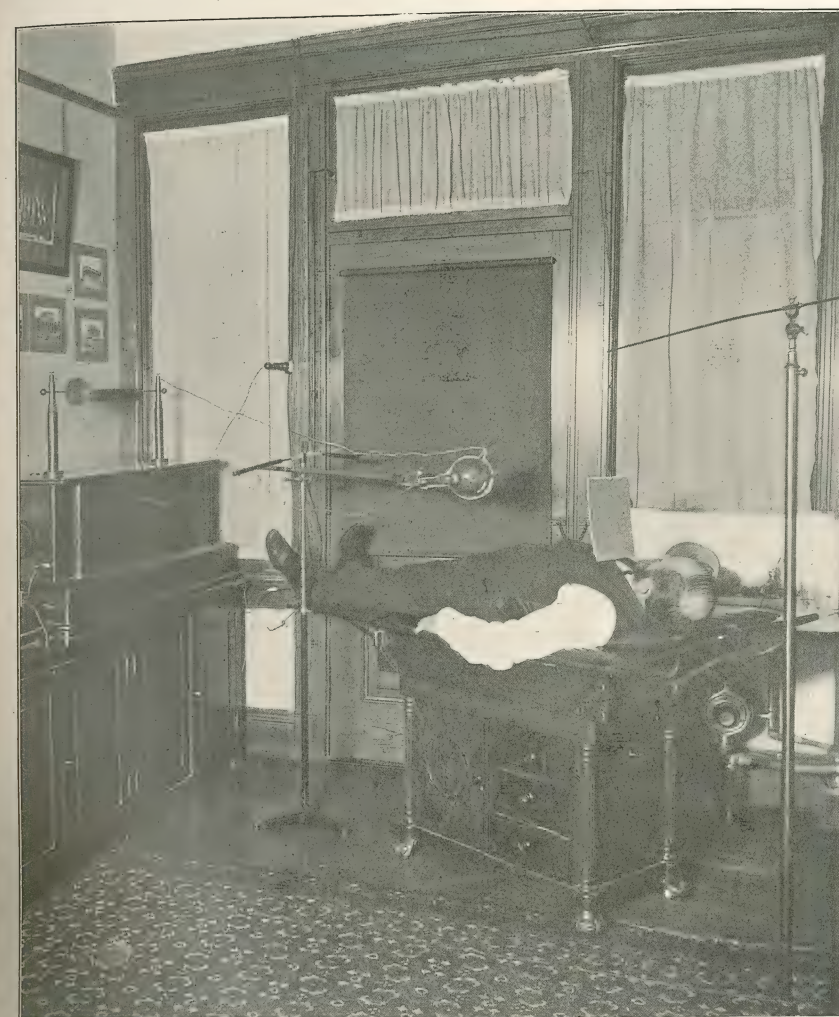


PLATE 161.—Knee. "Mr. H., age fifty-five, Rheumatic Diathesis. Report of similar case treated eight months ago encouraged me to experiment with the Rays in this sort of condition. Patient is practically well. Whether due to the influence of the Rays or to the dietary conditions imposed upon him, am unable to say. He believes it to be the former." The valuable Instruction Plates teaching methods of X-ray Therapy and marked in this section with the name (Blackmarr), were photographed especially for this work by Dr. F. H. Blackmarr of Chicago, whose note accompanying them contained the following line: "This work, the X-ray treatment of pathological conditions, was begun by me somewhat over three years ago, and although I have met with many discouragements I am thoroughly satisfied that the X-ray will become one of our most positive therapeutic agents." Our limited marginal space has prevented inserting the doctor's full description in some of the cases.



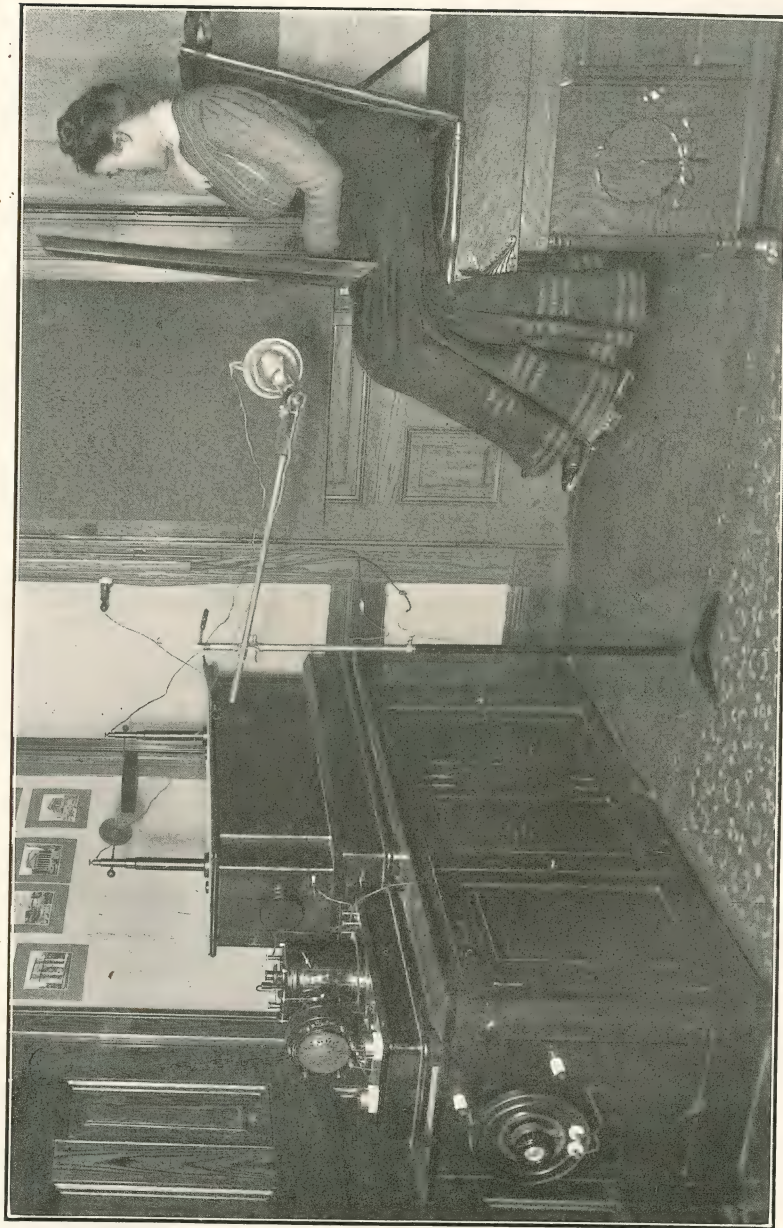


PLATE 162.—"Tubercular Knee-Joint. This went through the ordinary palliative treatment, etc., in the hands of one of our best Chicago surgeons, and amputation was advised. X-ray treatment lasted from April 19 to June 19, 1901, result satisfactory. Patient uses limb as easily and readily as one never having suffered. Position of tube shown in photograph, and position of large mask demonstrate method. Tube used, medium vacuum, twenty minutes to ten minutes daily exposure." (Blackmarr).

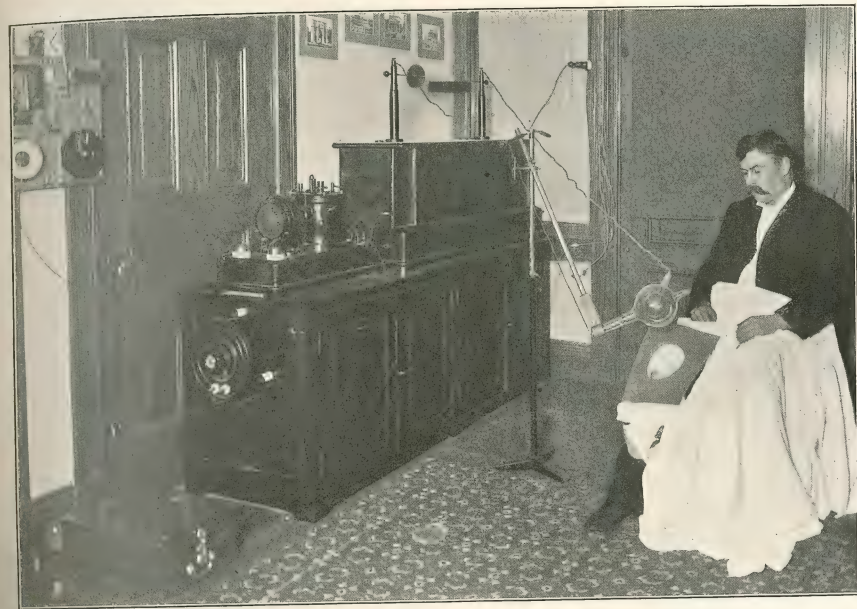


PLATE 163.—"Tubercular Knee-Joint. Photograph demonstrates method of treatment. Sheet-lead mask used; treatment lasted a period of two months. Very severe burns resulted; knee-joint improved to such an extent that patient can move joint. Two months have passed; reason for non-recovery of patient from burn is the general atonic condition of patient." Case treated by Dr. F. H. Blackmarr, Chicago, Ill., and photographed especially for this book.



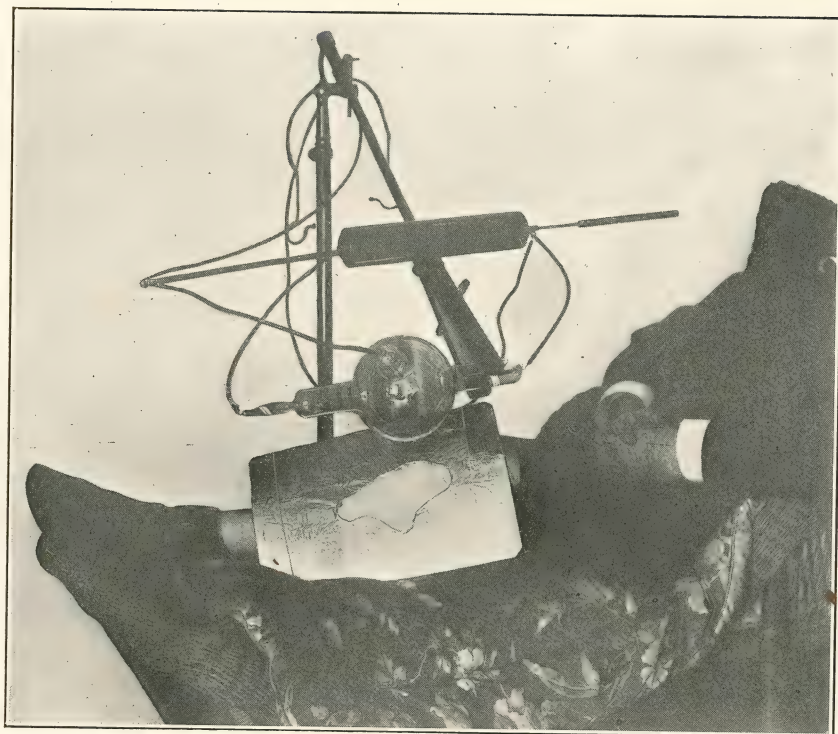


PLATE 164.—Raying a case of psoriasis, or ulcer on leg. This Instruction Plate shows a foil-covered card-board cut to fit the margins of a patch of psoriasis. A thin layer of surgical cotton is placed over the patch, and the shield is then tied on the leg with two strings. The patient rests easily on a couch. The tube is seen connected with the Bario-Vacuum Automatic Regulator, and correctly adjusted over the lesion, but for convenience of photographing the wires are disconnected from the electrical apparatus. In treatment start the tube into action, and regulate the dosage by pulling out the rod seen at the right of the cut.

A second case of lupus under treatment at the same time presented interesting contrasts. The disease in this case was confined to a circumscribed area on the wrist about the size of a five-shilling piece, covered with dry scabs. It had been growing for two years, had occasionally ulcerated, and had been treated at intervals with ointments and lotions. The patient had suffered from bone necrosis of the corresponding hand. Applications were made twice daily, but otherwise the method was the same as in the preceding case. I used a sheet of lead with a hole cut in it for a protector. The hole was *too big*, and after eleven treatments a patch of brown discoloration appeared beyond the diseased area, which got sore, and required a discontinuance of the treatment for three days. After another thirteen treatments it broke out again, and I again had to stop. By this time several of the scabs had come off and the patch was looking very well, but the patient, contrary to orders, applied water-dressing to sooth the surrounding inflammation, and the general effect was discouraging to me, so that after thirty-one applications I sent her home with orders to return as soon as the surrounding inflammation had subsided. This was accomplished in about three weeks, but she never came back *because the lupus disappeared without any further treatment.*

"Six months later I heard from her physician, who reported that it had been slowly healing all the time. The only difference in the treatment of the two cases was that one was done *twice* a day and the other *once*. Some of the German operators have always made the applications twice daily, and I should have done the same in the first case had it not been too inconvenient for the patient. The dermatitis was probably due to my carelessness in making the hole in the lead protector too large. I am still in favor of treating lupus cases twice a day when possible, especially when time is of importance to the patient. The little extra soreness is compensated for by the gain in time. My second case got thirty-one applications between March 3d and March 27th.

"So far my experience with the action of X-rays on lupus corresponds exactly with that of my Continental predecessors in the field; and, indeed, what struck me most when studying the literature of the subject was *the extraordinary similarity of process and results that they all got*. There was among Kümmull's cases one which did not yield to treatment—a boy suffering from what had been considered lupus of the face. Two weeks' treatment produced no effect whatever, so it was given up. Later it was found that the boy was suffering from syphilis, and he got rapidly well under specific treatment. Two French physicians reported a case of supposed lupus in which X-rays had no effect, and in these there was also a history of syphilis.

"Among all the operators Professor Schiff seems to have been the most successful in *avoiding dermatitis*. In fact his first experiments, which were made on *epilation* cases, were undertaken for the purpose of showing that *the dermatitis was not a factor in the thera-*



peutic process, a point which at that time was held in question. His observations are especially valuable. When he wished the action to be very slow and gradual, as for epilation, he used low currents, tubes of low intensity, gave short exposures, and kept the tube further away. What he calls the intensity of the tube he measured by the distance at which it would show the bones of the hand on a screen. This varied from six inches to three feet. The voltage of the current varied from ten to thirteen, the primary amperage from one to three, the time of exposure from ten minutes to twenty-five minutes, and the distance of the tube from four inches to ten inches. Schonberg later published the reports of nine cases, all successful, using higher voltage and amperage, and most of his cases got dermatitis.

"My Static machine has twelve twenty-four-inch revolving plates. A high-vacuum tube gives beautiful screen effects. I was assured that it would not be good for therapeutic purposes, but I determined to try. I did my first case of *hypertrichosis* with it. It was very slow, but the result was excellent in the long run. There was no inflammation; a good deal of brown staining which remained long after the hairs had come out; and the skin felt a little bit sore and stiff.\* The hairs all lost their color before they came out. The case had thirty applications, but ten days were lost in the middle of the treatment by lack of experience on my part. Instead of using a mask, as I usually did, to protect the face I simply laid sheets of tin-foil over the face with nothing between them and the skin. The result was that she got a sort of erythematous eruption over both cheeks with slight swelling and a great deal of heat and soreness; her eyes were suffused and some of her eyebrows came out. *The part of the face that had been left uncovered was not affected.* She recovered in ten days. After that I always used a mask and it did not happen again.

"A few days afterward exactly the same thing happened with another case when I was using the coil. I had left off the mask and covered one side of the face with tin-foil, and in a few days a patient complained of her cheek being sore, and I saw exactly a repetition of the first case. I stopped at once, giving the face a day's rest, and it was all right by the following day. I took the warning and have never since worked without a mask lifted from metallic contact with the skin.† (See Plate No. 173.)

"The course of this depilation case treated with the Static machine exactly corresponds to the description given by Schiff of his first coil cases as to the length of time, the brown discoloration, the decoloration of the hairs, and their *disappearance without the slightest sign of in-*

\* The negative static breeze on the bare skin relieves this condition beautifully. (S. H. M.)

† The direct irritant action described above (which passes into inflammation and will produce an ulcer if continued long enough) is caused by the short electrical spark-discharge between the charged metal and the dry skin, and is easily avoided by either perfect electrical contact or by placing the metal so far from the skin that the well-known "static effect" will not take place. Although the author of the above article "does not understand the action" it is one of the familiar phenomenon in connection with electricity, and has been remarked for over 200 years.—AUTHOR.

*flammation.* In fact until the hairs actually came out, the patient refused to believe that anything at all was taking place. He says, and I have found it to be so, that there is *much less chance of recurrence after this process*, and that it causes atrophy of the hair-roots and not inflammation. The only drawback is the patient's scepticism. They cannot believe that anything is going on when there is nothing to be seen or felt, and for that reason I generally adopt the more rapid method with thicker currents. Even with the coil treatment patients vary much. Where one would be quite sore after eight applications another will feel nothing even after twelve or even more. For instance, I have a case under treatment now with the coil. She had thirteen applications in three weeks before she felt anything at all. Then she felt sore and stiff, as though the skin were stretched. Now the hairs are coming out and she is reassured, but she was very discouraged at first because she thought that nothing was happening.

"The next case treated with my Static machine was an *eczema*. I used the same tube as in the previous case. The *eczema* was a small patch on the hand. It had appeared after a burn three years ago. I treated it *eleven times, from fifteen to twenty minutes, with the tube six inches distant*, carefully protecting the rest of the hand. It simply faded away, getting paler and paler each time. *There was no inflammation or soreness.* At the present time you could not tell which hand it had been on. This is the only experience I have had with the influence of X-rays on *eczema*, and it is not a very good one, as the diagnosis is open to criticism, but the fact remains that it was healed without the slightest sign of inflammatory reaction. Hahn reported success in three cases of chronic *eczema* in July, 1898. The disease disappeared rapidly after ten to sixteen applications in all three cases, and only in one was there any inflammatory reaction. He used the coil and made applications daily of twenty to twenty-five minutes with the tube twelve to fifteen inches away. *In my case the tube was not more than five or six inches away. The process was as rapid with my apparatus as with his.*

"This rapid action has also been strikingly illustrated in another case, viz.: *psoriasis*. In Germany *psoriasis* is considered a parasitic disease, and was therefore held to offer a good field for the action of the rays. The patient had the disease for twenty-five years, and had tried every treatment that had been devised for it. In places it was in isolated patches, but in other places there were large areas where you could see no skin at all. I began on a small patch which I rayed through an opening in a sheet of lead with the tube and current the same as in the case of *eczema*. The effect was exactly the same, *the spots fading away without the slightest sign of inflammatory action.* The brown pigmentation appeared, at first in the healthy skin on the margin of the diseased area, and, as the disease disappeared, in the healthy skin that replaced it. *About twelve applications were necessary to insure the disappearance of each patch.* After the first patch treated had disappeared, and, finding that there was no danger



of dermatitis, *I gave up using a protector, and I think that I have established the fact that a tube excited by a Static machine will not ordinarily produce dermatitis in this form of technique.*

"Twenty minutes a day for twelve days on the same area did not even redden the skin, but by way of an experiment I subjected one untreated area to a tube excited by a twelve-inch coil worked on the 100-volt alternating circuit with an electrolytic break. The average current passing through the primary was three amperes, and the parallel spark-length was about two inches. I began with five minutes exposures, but as nothing alarming happened I increased them to fifteen. The skin got a little sore, but the effect on the disease itself was nothing like so good as with the other tube. The case is still under treatment and likely to afford a field for study for many months yet. (See Plate No. 164.)

"I found that at whatever stage of their development I attacked the spots they never got any further. Those that were treated from their first appearance as tiny pimples never grew at all, and those that were already ripe gradually faded away, and not as they normally do by healing from the middle outwards. Again, I found that many of the spots after about six applications, if left to themselves, disappeared without any further treatment, but I also found that they came back again, while those that I treated continuously until they disappeared did not come back. The same thing may happen with *lupus*. The explanation is probably this: The rays have a healing or revitalizing effect on the inflamed tissues enabling them to combat the disease of which they are the outward and visible signs, but the disease itself is not affected at this stage. That does not take place till later, for most of the efficiency of the rays will be absorbed in the hyperæmic tissues.

"I think there can be no doubt that to permanently alter the condition of the skin the rays must be conveyed to the corium, where all the energizing organs reside, and where the parasite—if there be one—is to be found. If you set up a superficial hyperæmia before this has been accomplished, it forms a sort of defence of the deeper layers and you defeat your object. If you have a ready-made hyperæmia to deal with you must get rid of it first, and then you may hope to reach the actual seat of the disease. Similarly with regard to the removal of hairs. You want the action, whatever its nature may be, to take place in—and, if possible, to be confined to—the corium. If you start by exciting a superficial hyperæmia you intercept your agent before it gets to the seat of operation. The hairs may come out, but they most certainly will come back again. As an example I may mention a case that was recently described. A patient was rayed for an extensive growth of hair. I think she got something like eleven hours' treatment in fifteen days. Intense inflammation was set up, going on to ulceration, but the hairs did not even come out. The process that permanently removes the hairs is not, I am almost sure, a true inflammation. I am inclined to think that it is a tropho-neurotic one. At

the time when the hairs are coming out the patients say that the skin feels stiff and numb, not so sensitive to the touch as the normal side, and the hairs, if you examine them, present the same appearance as hairs from a patch of alopecia areata.

"X-ray inflammation, according to Kaposi, does not differ pathologically from any other inflammation, but he suggests that there may be another action of the X-ray on the exudation cells, and the newly formed young cells, bringing about fatty degeneration and causing their reabsorption. This observation of Kaposi was called forth by a case of Schiff's, of *lupus erythematosus* of both cheeks. It was thought that this disease was not amenable to X-ray treatment. Schiff did not expect to succeed, and was greatly surprised to find it disappear with rapidity. In less than two months one cheek was clear of the disease. His primary current was three and one-half amperes, thirteen volts; distance of tube, four inches; length of sittings, ten to fifteen minutes. He generally used a new tube which he only describes as emitting an intense light.

"Our knowledge of the usefulness of this form of treatment is extending every year, and preconceived views of its action have to be given up in favor of broader ones. My own small but varied experience inclines me to think that the key to the action is still missing. How, for instance, are we to reconcile the different and exceedingly opposing actions of the X-rays which have come under my observation? There is the revitalizing action as shown in their effects on scar-tissue, there is the antiphlogistic, as when the psoriasis spots fade away; there is the inflammatory, which may go on to necrosis; and there is yet another, which I shall go into more fully presently, viz.: bactericidal. I must also mention the analgesic action. Dr. Gocht treated in this way and speedily cured a case of trigeminal neuralgia of several years standing. He also removed the pain in two cases of mammary cancer. Is one agent to be held accountable for them all, or is there more than one acting simultaneously? Are the different results obtained from different apparatus to be accounted for by the varying co-relation of these agents in each case?

"Interesting to consider in this relation are the experiments of Professor Finsen with sunlight and electric-light. In 1893 he proposed a new treatment for small-pox, which consisted in placing the patient in a room from which the chemical rays of the solar spectrum were excluded by means of red glass. The result was that the development of the spots was arrested. There was no suppuration, no scar, and no secondary fever. The exclusion of the chemical rays appeared not only to protect the skin from harm, but at the same time enabled it to be exposed to the beneficial action of the other rays. For years he continued his researches into the irritating and destructive influence of chemical rays, and about three years ago established some points of similarity between them and the X-ray, and they are both potent to cure *lupus vulgaris* and other parasitic diseases of the skin. For



these purposes he now uses concentrated electric-light, eliminating as far as possible all except the chemical rays.

"Still nearer in similarity to the X-rays, both physically and therapeutically, are the rays emitted from an electrified point by a high-potential current. A metal point connected with the pole of a Static machine, especially the negative hole, produces them in great abundance.\* They will affect a photographic plate in the dark even at a distance of a foot or more, in a few seconds, giving a well-defined shadow of any opaque substance placed between them and the plate. They are absorbed in the blood-vessels, can penetrate the skin, and provoke to activity the sweat-glands. They are antiphlogistic and analgesic, can be concentrated by lenses and are much used on the continent in the treatment of skin diseases. I have never known them to produce the slightest irritation of the skin. They provoke phosphorescence and fluorescence, will pass through white glass, but not green, yellow, or red, and substances which are transparent for X-rays are not transparent for them. They seem to possess all the properties of the ultra-violet rays of the spectrum, and their action on the organism resembles closely the action of X-ray tubes with the X-rays proper left out. Plainly, they are not X-rays.

"If then, as seems likely, the X-rays proper have not part in the therapeutic action, then must our theory that a soft tube is better than a hard, because it has not got so much penetration, be given up, and we must seek some other standard of usefulness. I used a soft tube with my lupus cases, but Schiff did not. On the other hand, I used a high vacuum tube with my Static machine till it got so high that the current refused to go through it, but *I do not see any difference in the action*. There is, however, a great difference between the action of a tube excited by *heavy* currents and *small* currents, but I do not think this difference dependent on X-rays proper. However little we may know about their nature and method of working, we can no longer doubt that we possess in the so-called X-rays a very valuable therapeutic agent. Does a skin specialist ever pass a working day without seeing in his consulting-room some one whose life is more or less spoiled by the burden of some chronic skin disease that does not endanger life but which the most skilful treatment can only temporarily relieve? At present our knowledge of this action is limited to a few of these diseases, but I feel sure that further experiments will open up a wider field of action. It is true that the treatment is long as compared with some, but if done with care it is painless. For lupus above all it has many advantages. It does not make invalids of the patients, even temporarily; it saves them from disfigurement; and even in cases where disfigurement would not much matter an operation necessitates the unpleasantness of an anæsthetic, of a period of detention in a sick-room, and of a long convalescence while the wound heals.

"As to *recurrence* I think we have every reason to be hopeful on

\* See "Static Sprays" in my book on Static Electricity. (S. H. M.)

that point, especially when the treatment is continued, as I have above stated. As to the dangers in X-ray therapy they are now very small. From my own experience I should say that by strict attention to the rules of technique and by daily personal observation of the patient any serious accident may be avoided. We hear of cases in which dermatitis was set up after one sitting, and once in 2,000 cases Schonberg had such a thing happen, but if certain precautions are observed at the commencement of each case it will be prevented. No two patients ever behave alike, and you must take the measure of sensitiveness of each one. There are four details of the operation which require regulation:

- "1. The distance of the tube from the skin.
- "2. The length of the sitting.
- "3. The strength of the current.
- "4. The vacuum of the tube.

"Begin with the tube at eight inches and limit the sitting to ten minutes until you are sure that the patient is not particularly sensitive. You can then gradually lessen the distance to four inches and increase the sittings to twenty minutes or even more. As to strength of current, I believe that the *amperage* is the important factor. When we wish to increase the intensity of action we increase the *quantity of current*. The protection of the healthy parts is very important. For the face I always use a mask covered with tin-foil. I cut a hole in it corresponding to the part to be rayed. It is not, of course, necessary to cut an actual hole. It is sufficient to strip the tin-foil off the mask. But I prefer to cut a hole because it gives the patient more air, and some face-masks are hot and uncomfortable things. If you are raying a face the chest must be covered with sheets of tin-foil. For the limbs I find sheets of lead with holes cut in them convenient. At the first sign of reaction, stop the treatment for a time, unless you are perfectly certain of your ability to keep it under control, which only experience will enable you to do."

"In the early part of this year I had four cases under X-ray treatment, one psoriasis, two lupus, and one epilation. I was using a twelve-inch coil with an electrolytic break. My tube was never under six-inch spark, and toward the end had gone up to 7.5 inch spark. The cases had all been under treatment several weeks, were making satisfactory progress, and had shown no signs of dermatitis. They all showed the characteristic brown staining. When the resistance of the tube had got so high that I had difficulty in getting the current across I changed it for one with a spark length of only four inches, giving very much less green hue to the bulb and a visible stream of violet discharge from the anode. Within ten days every one of the cases had dermatitis. There can be no doubt that it was caused by the comparatively low vacuum of the tube, as the details of use were not changed in any other respect. Moreover, this same tube, with its resistance raised to 5.5 inches and no violet discharge visible, is now doing good work without any accompaniment of dermatitis. I had



never before used a tube in which violet rays were visible with the green phosphorescence, and I never before had a case of dermatitis in my practice. I have been asked whether the advantages of a soft tube in treating skin affections are enough to counterbalance its dangers. Since the beginning of the year 1900, I have had opportunities of comparing the actions of soft and hard tubes on the same subject, and my judgment is in favor of the hard tube. This reverses my previous opinion, but is justified, I think, by my recent experience."

Second and later section of paper by Dr. Sharpe:

"Prior to the latter part of 1899 we in England were indebted for most of our knowledge on X-ray therapeutics to the labors and writings of our colleagues on the Continent, and our own practical experience was of the smallest. Now things are very different. X-ray departments have sprung up in many of our large hospitals, both general and special, and our skin specialists have introduced the treatment in their consulting rooms. Cases we have had in plenty, and a considerable measure of success has rewarded our efforts—enough, I should think, to shake the doubt of the most sceptical; but are we still open to the reproach of dealing with a little understood force? Are we agreed as to the nature of the therapeutic agent, or the nature of its action, or as to whether it is simple or complex, one or many? And then, again, there is the vexed question of dermatitis—what produces it? Can it be prevented? And is it desirable to prevent it? And so on.

"I myself have lately arrived at some very definite conclusions on these points; how long they will hold out I don't know. And, first, with regard to *dermatitis*. Until the beginning of the year 1900, I had never had a case in my own practice, and I was much puzzled to account for the immunity I enjoyed. I did everything I ought not to have done; I put the tube as near as possible to the skin; I gave long exposures, fifteen to twenty minutes, once and sometimes twice a day; and I did not protect the healthy parts except on the face. My house is on the alternating circuit, so I use that to excite my coil, with an electrolytic break, or else I use a Static machine. I had never used the continuous current, and I did not know any one who worked under the same conditions, so I could not compare notes; hence, I naturally began to consider that my immunity from accidents was due to the form of current. I was quite wrong, as I was soon to learn.

"For therapeutic work I always use the same tube, and continue using it till the vacuum gets too high for the current. This generally happens with my coil when the parallel spark gets to seven or eight inches. On one occasion I got a new tube which was down to a four-inch spark, gave a very good fluorescence and plenty of X-rays, but showed a very distinct *violet* stream between the electrodes in the tube. I started to use it with all my cases without the slightest thought of danger, and they all, with one exception, got dermatitis—the one that escaped being a case that was only rayed once or twice a week. I see no loop-hole of escape from the conclusion that the condition of the

tube caused the dermatitis, for *nothing else was changed*. Moreover, by the time the dermatitis showed itself, which was from seven to ten days after I began using the new tube, the vacuum had gone up, the violet stream was no longer visible, and I went on using the tube, and am still using it, and *have had no more dermatitis*. This experience coincides with that of operators in the early days of radiography, when the use of low tubes and long exposures was so often followed by dermatitis. The low tube rather than the long exposure must be regarded as the prime factor in this causation.

"This question of the causation of dermatitis has been greatly obscured by the extremely careless way in which cases are reported. Even where details are given as to strength of current, time, distance of tube, etc., how very seldom is any description at all given of the tube itself. This, then, is my first point: that dermatitis is due to a condition of the tube. I think that dermatologists are agreed that X-ray dermatitis is the same as that produced by the violet rays of sunlight and of electric-light, which is still richer in violet rays than sunlight. Then comes the question: Is the dermatitis a *necessary* accompaniment of the X-ray treatment—to be used, but regulated? On this point I adhere to my opinion of 1899. It is, as it were, a by-product. *It is not only no help, it is a hindrance*.

"I do not say that dermatitis will not cure certain skin diseases. It is well known that chronic inflammations can sometimes be cured by acute ones, but what I do say is, that it is not the *X-ray* cure. Moreover, I believe that the two effects are produced by two totally different agencies; not even by different degrees of the same agent. It may be, and probably is, the case, that dermatitis is produced by violet light rays, but the X-ray cure proper is probably not due to any kind of a light-ray, but to *electric current*. This I know is a flat contradiction of a statement I made in 1899. At that time many scientists, both at home and abroad, suggested that the therapeutic effect of X-ray tubes was due to electric discharges, which suggestion I treated with scorn, because I had been working with powerful electric discharges for years, and had never seen any effect produced on the skin, either for good or ill. *I know now how I was misled*, and it confirms me in my present view. Even at that time my attention had been drawn to some similarities of effect of an electrical discharge and an X-ray tube. They both will affect a sensitized plate; they will both provoke fluorescence; they will penetrate the skin and act on the blood-vessels and sweat-glands. Electrical discharges will pass through white glass, but not red, and they have been in use for three or four years in France in the treatment of skin diseases. They both have very marked analgesic properties. All these things have been theoretically known to me for a long time, and it annoyed me not a little that, possessing as I do an electro-static machine giving a brush discharge two or three inches long, I yet could not get the skin effects reported by the professors at Lille.

"The mystery was cleared up in a rather roundabout way. I was



endeavoring a short time back to get some information on the phenomenon of fluorescence, and I came upon an article in which it was ascribed to the action of oscillating high-frequency currents. Now, I was very much interested in oscillating currents at the time, as the French journals were full of accounts of their action on *lupus* and other skin diseases; so I set to work to study the fluorescing action of electric discharges, working with my Static machine. I found that the most brilliant effects could be produced on the fluorescing screen, but only when it was held close to the point giving off the discharge. Now, if the special skin action is due to the same property of the current that produces the fluorescence it is probably inactive at a distance beyond which fluorescence can be produced; hence, the fact that patients ordinarily treated with brush discharges are not subjected to dermatitis. I experimented on a patient who had a patch of *lupus* on her arm, and the result was excellent. High-frequency currents also produce fluorescence at close quarters. Here, then, we have the same phenomena produced in three different ways, by an X-ray tube, by high-frequency currents, and by static-brush discharges. *All three possess similar therapeutic powers*, and it seems to be highly probable that *the same agent* is at work in all of them.

"For the last two months I have been using the tube and the high-frequency currents on the same patients to test the similarity of action, and I will give you the result of my observations. But I must ask you to bear in mind that my H. F. currents are not produced in the orthodox d'Arsonval, but after a fashion of my own. I had an Oudin resonator made according to directions given by the professor in one of his published papers, and I attached it to my *Static machine*.<sup>\*</sup> It works very well. I had at that time a patient who had three patches of *lupus*—one on her nose, one on her arm, and one on her leg. The nose had been under treatment twice before, and both times the treatment had been given up before obtaining a satisfactory result. The patches on her leg and arm were quite fresh, of much the same age, and covered up with piled-up rupoid scabs that made me think there was probably a congenital specific taint complicating the *lupus*. After the scabs had come off, I treated the leg with the X-ray tube, the arm with the brush discharge, at first direct from the Static machine, and afterward from the high-frequency attachment. The two patches behaved in exactly the same way and kept pace with one another; perhaps the leg got on a little faster. The treatment with the X-ray tube was kept up for ten minutes each day; with the electrical discharge, for only from three to five minutes, yet the results were equal.

"But a still better case turned up shortly afterward. This was a woman with an exuberant growth on the end of her nose, making it about the size of a billiard-ball. The whole of the end of the nose was concealed in the mass, with the exception of the left ala, which

<sup>\*</sup> The high-frequency attachment for Static machines is now regularly made in this country and its uses will be taught in a later section of this course.

had only one or two isolated tubercles on it. The mass rose abruptly from the skin, the surface was roughly granular, intensely red, bleeding easily, and exuding a sanious foetid discharge. It was not, and never had been, ulcerated, and there were no scabs. It was said to be about two and one-half years old. It had been diagnosed by an eminent London specialist as tuberculosis, and he had treated it for three months with an ointment containing pyrogallic and salicylic acid with no result. The right half of the upper lip was covered with a thick hard patch, which had been there seven or eight years and had been scraped. The patient suffered no pain whatever and her general health seemed good; but she said pathetically that she was very tired of her nose. And no wonder! I contemplated it with some dismay. It was not a nice thing to meddle with, and only the reflection that no nose at all was better than such a nose emboldened me to undertake the treatment.

"I treated the left and least involved side *with the high-frequency current*, actually sparking it for from three to five minutes. The tumor itself was very insensitive. The right side I treated with the X-ray tube for ten minutes at a time, always with the tube at *the highest possible degree of X-radiancy*. The effect was immediately apparent. The surface of the tumor became drier, smoother, and paler, and the next day there were small scabs scattered over it. *Exactly the same effect was produced by each method of treatment*. The redness and swelling which had extended up the nose nearly to the bridge also gradually diminished. She has now been two months under treatment. The same process repeats itself again and again; the scabs form, come off, leaving a raw, granular surface, more scabs form, and the tumor steadily diminishes. The fetor entirely disappeared the first week of treatment. In one particular the high-frequency current seems to work better than the tube, and that is when long-standing disease has left great thickening. I found that was the case also with another patient who had suffered for thirteen years, and with whom the disease had been quiescent for eight years, so that now I am treating the woman's upper lip with a high-frequency current, although it is properly the tube side of her face. There has been no sign of dermatitis.

"This case has strengthened my belief that the same *therapeutic agent* must be at work in both methods of treatment, and that it is not the same agent that produces the dermatitis. Certain phenomena that I had noticed in the early days of my work with X-ray tubes then came back to me. At one time I was treating a very bad case of psoriasis, where there were large patches of abnormal skin which changed very rapidly under X-ray treatment, sometimes even after one sitting. I soon began to notice that there was a very well-defined area of activity of the tube. I could easily distinguish a round patch of healthier looking skin in the midst of the diseased-looking area; but when this patient became a victim to the soft tube already mentioned the inflammation extended far beyond this healing tract. I have often noticed, too, how the dermatitis has a trick of appearing when you don't expect



it. I then examined the tube with the fluorescent screen for the area that would correspond to the healing area on the skin, and I found it represented by a fairly definite area, giving a more intense fluorescent effect and coming always from a part of the tube opposite the edge of the anode—that part of the tube that would be affected by brush discharges from the edge of the platinum plate.

"I have said that this area on the screen is one of more intense fluorescent effect, but I am not sure that this is correct. I have thought that fluorescence proper only shows itself in that area, and that the transparency of the rest of the screen is simply illumination. Illuminating rays act on all parts of the tube in front of the anode, which is the source of the X-ray light. If you send a current into a tube that has lost its vacuum, you will see the discharges flying off the edges of the electrodes to the glass of the tube, and wherever they touch the glass wall you will get fluorescence, though there is no light in the tube and no X-rays. And here again you will only get the fluorescence at close quarters. Then the question naturally suggests itself: If the fluorescing agent from the tube is an electric discharge, like other fluorescing discharges, how is it that it will act at so much greater distance? The reason may be that the currents use the X-light-rays as conductors. All ionized gases are conductors of electric currents. The practical outcome of it is this: The therapeutically active area of a tube is that represented by this intensely bright spot; that this spot comes from the part of the glass-wall of the tube that would be most powerfully affected by brush discharges from the anode; that the brighter the spot the more marked is the therapeutic effect, as I have found by experience; and, finally, that the agent in the formation of this bright spot is an electrical discharge.

"One more remark I want to make on the comparative effects of X-ray tubes and electric currents, and that is, in the removal of hairs. There are, I know, skilled operators who are content to perform that operation without avoiding the dermatitis which they think is a necessary part of the process. I still maintain, as I did in 1899, that they are wrong, and I am glad to see that Schiff also still clings to his first method, and avoids the dermatitis as being unnecessary. The only case of dermatitis that I had in a case for the removal of hairs was the only case in which the hairs did not come out. In all my other cases the hairs came out with nothing more than a slight soreness of the skin, and they have not returned. One of my cases has now been two years under observation, and another for three years, without a new growth of the hair.

"And this effect, what is it physiologically? As regards the hairs, I think that it is plainly enough a prolonged constriction of the vessels, ending in starvation of the papillæ and hair-roots. A hair that is extracted after long tube-treatment has no root; it ends in a point, with no structure at all to speak of, and no medulla. Probably there has been electrolytic action as well. The action on new growth is, I think, explainable on the same theory. The superficial layers of epithelium

undergo starvation, necrosis, and shed themselves in scabs. New growths of epithelial tissue are easily starved. The cells are not in very intimate connection with their blood-supply. The action only affects the superficial layer, and a process of gradual destruction goes on which would not be sufficiently powerful to injure more highly vitalized tissue. Having destroyed the growth, the next thing required is to restore the normal tissue from which the disease has sprung until it has attained strength to fight its own battle and no longer offers a suitable field for the growth of germs, and electric currents certainly do this. The treatment of rodent ulcer ought to show this process well. Two cases that were treated in the Finsen Institute last year seem to have behaved much as the nose that I have spoken about.

"There is an erythema which is produced by electric discharges, which I have also seen after prolonged use of the tube, and which has, I believe, in many cases been mistaken for X-ray dermatitis. I have seen it mentioned in reports of cases where very brilliant tubes have been used, but the reports have not distinguished it from X-ray dermatitis, though it is very transitory, while we all know that the other is not. It always appears after severe applications of high-frequency currents, is slightly sore to the touch, and lasts two or three hours. It is much more pronounced in hairy tissues, where it generally produces slight swelling, the soreness is more pronounced, and the condition remains for two or three days.\* I have often seen it induced by the careless adjustment of the tin-foil masks. It is easily distinguishable from X-ray dermatitis by its beginning superficially. If it has been at all severe the skin peels after it.

"It is now the generally accepted belief that hard tubes never cause dermatitis. I never use screens except for the face, and then only to protect eyelashes and eyebrows, and I make them of an ordinary toy mask, which I cover with tin-foil on the outside next the tube, and I take care that the edge of the tin-foil does not touch the skin. I never use any screen with the high-frequency current, nor do I cover any part of the tube. With the theory that not washing the skin will insure you against dermatitis I entirely disagree, and I never tell my patients not to wash their faces when I am treating them for superfluous hair. On the contrary, when hairs have become deteriorated in the course of treatment, a good rub removes them. The way to avoid dermatitis is never to use a soft tube, and if we give up the theory that the therapeutic effect is due to X-rays there is no object in using a soft tube, while, on the other hand, if we consider this effect to be due to electrical discharges it does not matter how hard a tube is. Many operators, beside myself, have commented on the difficulty of producing a dermatitis to order. Many of us have tried and failed."

\* Sedation with a negative Static breeze by the author's method relieves this condition in five minutes usually. (S. H. M.)



## CHAPTER XXXIX

### THE X-RAY TREATMENT OF LUPUS

#### TECHNICS AND RESULTS. DIRECTIONS FOR APPROVED METHOD.

LUPUS has been the great battle-ground on which X-ray therapy has won its chief recognition, but the world-wide interest in its action in this disease springs in part from the hope of finding in some feasible form a remedy against tuberculosis and cancer. We shall presently take up these diseases in connection with the X-ray, but first invite the careful study of readers to what many now consider "the positive cure of lupus." Deriving the most instruction from comparing the views, methods, and results of different workers, we shall cover in this chapter the best that is known on the subject.

Holland's first cases were presented with the following paper on December 10, 1898:

"Since June 1, 1896, to the present date, I have taken 725 radiographs, the plates of which I have kept. In addition have made a number of unsuccessful exposures, and done a very large amount of fluoroscopic work. Further, I have superintended the X-ray work of a friend for more than a year, his apparatus being in daily use. The coils have been three-inch, six-inch, and ten-inch, and the exposures have varied from a few seconds up to an hour. Several abdominal and hip cases (all long exposures) were within a short space of time exposed two or three times. The tubes have been placed at distances varying from four to fourteen inches from the skin. The apparatus used has been the simplest—an accumulator, a coil, and a tube. No attempt in any case at any protection. With this somewhat extensive experience I had never seen the slightest damage of any kind, not even the removal of a single hair nor the appearance of the slightest redness of the skin. In April of this year, 1898, hearing that lupus had been successfully treated by X-rays I borrowed two cases to see what could be done.

"Case 1.—A girl. The photograph taken, 1898, presenting a chronic irregular punched out, tubercular ulceration in the foot which lasted for eleven years. It was at that time very painful, discharging freely, and almost incapacitated the girl from walking. Varieties of treatment had been unsuccessfully tried. All treatment

except the use of boracic ointment was stopped, and, between April 18 and June 14, 1898, the foot was exposed to X-rays nineteen times. The glass wall of the tube was placed four or five inches from the skin, and the anode was kept red hot during the time of each exposure.

"A ten-inch coil was used each time except once, when a six-inch was used. On May 24th the ulcer was much better. On May 31st there was no discharge. On June 14th, when X-ray treatment was stopped, all pain had ceased, there was practically no discharge, the nails of the toes were all loose, and a slight erythematous blush extended over the dorsum of the foot and a little up the leg. The girl could wear a boot and walk with comfort. No further treatment was given until November 15th, when the second photograph was taken. We have only to compare these two photographs to see the great change in the appearance. Am now commencing to give the foot a few more exposures.

"Case 2.—A boy of sixteen with a large ulcerating lupus attacking the left face and left ear with discharge from the ear. It was of five years' duration and had been constantly scraped and caustics applied with but very temporary benefit, and the lupoid patch was slowly extending in area. On April 18th all treatments were stopped except boracic ointment.

"Between April 18th and June 14th he was exposed seventeen times, for fifteen minutes at a sitting. The ten-inch coil with a tube, the anode of which was kept red hot, was used on all occasions except one. The glass wall of the tube was four or five inches from the skin. After eleven exposures some hair on the side of the head next to the tube began to come out, and was so rapidly shed that in a few days he had an absolutely bald patch extending in a semi-circle from behind the ear upward to the forehead. The line was a most perfect regular curve. It seemed to me to more or less accurately correspond to the margin of the screen of X-rays. At this time the lupus was drying up so that he was able to leave off the ointment and wear no dressing at all. On June 14th, the date of the final exposure, it was practically healed. Seen again on August 11th it was entirely healed. There was no sign of recurrence, and the hair was growing well again. The beginning of October I showed the boy at the Liverpool Medical Institution, and the dermatologists there, four in number, agreed that the case was cured and that there was no evidence of lupus at all. In this case no other effect occurred beyond the loss of the hair, and this rapidly renewed itself. There was no dermatitis set up either in or around the lupus, and no attempt at protection of the surrounding parts was made. Photograph No. 4 shows the present condition of affairs taken in November. The scar is white, soft, and healthy looking, and presents no suspicion of any lupoid disease. (See Plates No. 169 and 170.)

"In another case of lupus I have tried this treatment—a boy of eighteen with a patch similar to the last, except that there was no



involvement of the ear and it was on the opposite side of the face. It was of eleven years' duration, but it was of the dry-scale variety without any tendency to ulcerate. This case was steadily getting worse and extending, notwithstanding scraping it at different times. Between June 27th and July 16th he had eighteen applications under similar conditions to the last case, except that the face and head around the lupus was protected with a piece of lead. At the end of the treatment the patch ulcerated all over, but rapidly healed with boracic ointment. I saw the boy quite recently and he certainly showed a change for the better, but the case was very far from being cured. He is now undergoing further X-ray treatment. One other case, not my own, I have seen—a young woman with a most malignant type of lupus, affecting the nose, lips, the mucous membranes of the nose, lips, and both cheeks. This case had been repeatedly scraped under chloroform, had had pure carbolic acid rubbed in, and so on. Only temporary benefit followed each operation and rapid relapse took place. Exposure to X-rays without curing has vastly improved this lupus, and she had a fairly long period of considerable relief and benefit following each course of treatment.

"Analyzing these cases: in that of the foot there was loss of nails and slight erythema. The nails soon grew again and their loss caused no inconvenience. In the two cases of lupus of the face: in one, the dry non-ulcerated form, the whole lupoid surface broke down into an ulcer; and the other, the ulcerating case, there was steady healing almost from the very first few applications, and, although some of the hair on the scalp was lost, there was never any sign of any inflammatory change of the skin around the lupus, not even the slightest redness. One point was of special interest in this case, and that was the sharp line of demarcation where the hair came out, a curve which might have been drawn with a pair of compasses, and, as I said before, it appeared to correspond very accurately with the margin of the X-ray screen, pointing to the probability that it was caused either by the X-rays themselves, or by some other rays coming off with the X-rays. The hair grew again very rapidly, and, if anything, more luxuriantly than before.

In a second publication, dated May, 1901, Holland continues:

"In December, 1898, I described a case of lupus of the face treated and cured by X-rays. Until May, 1900, the case remained entirely well—a period of nearly two years. Then there was distinct evidence of recurrence of the disease at the lobe of the ear and at the lower extremity of the scar close to the chin. These two parts became slightly scabby and inclined to ulcerate, the central scar area remaining quite healthy. Between May 9th and 21st I exposed the area again to the X-rays six times for ten minutes each, using a ten-inch coil with a mercury interrupter and a high-vacuum tube, a primary exciting current of from twelve to thirteen volts and six to six and one-half amperes, with a tube six inches from the skin. On July 24th, the lupus was again healed except for a

slightly suspicious patch just at the lobe of the ear, where it is a little scaly. The whole scar is very healthy looking, soft, non-adherent, and non-contractile. The lupus remained well until early in 1901, when the disease again returned not only at the lobe of the ear, but in scattered nodules, here and there, over the scar area. At this date, March, 1901, the case is having further X-ray treatment.

"On February 5, 1900, there came to me a girl eight years old with a lupoid patch on the left side of the face three-quarters of an inch below the eye, almost circular, and slightly larger than a half-penny. It was ulcerating, and scabbed over with a very thick scab, from the edges of which pus oozed out and the ulcerating edge was nodular. There was a family history of phthisis. The lupus began five years previously in a small pimple after an attack of measles and was treated with ointment. At intervals it was scraped under chloroform on three occasions. It never healed after these operations, but looked better for a time. It had no further treatment until August, 1898, since when it has been cauterized four times, the last time being six months ago. It has been gradually extending.

"On February 5, 1900, having stopped all other local treatment, I commenced X-ray treatment. Between February 5th and 17th it was exposed six times (using a shield of tin-foil) for six minutes, each time working with a ten-inch coil and a mercury interrupter. A high-vacuum tube was used at a distance of four to five inches. The primary exciting current was twelve volts and five amperes with a spark-gap of from eight to ten inches. On February 17th, a slight red blush was noticed around the scab and treatment was stopped, and on March 15th the scab came off and left a healthy-looking unhealed ulcer. On May 18th this ulcer was almost healed, but two small patches looked a little scabby and suspicious. Between May 18th and 23d she had four more exposures of ten minutes each under the same conditions as previously. On June 21st it appeared to be quite cured, and remains so now in December. On November 9th the second photograph was taken. The lupus is quite cured and its place is occupied by a soft, healthy scar, non-adherent and non-contractile. The latter point is well brought out by the fact that there is no pulling down or erosion of the lower eyelid. The scar is almost white, and at a few paces distant can scarcely be seen. In considering the treatment and its results, with the above cases before us, there are several points worth dwelling upon.

"1. It is not necessary to set up any primary effects such as dermatitis, etc. In the first case, no protection was used for the healthy skin and parts surrounding the lupus, and half way through the treatment a large patch of hair on the side of the head nearest the X-ray tube fell out. The hair grew again very rapidly. In the second case, layers of tin-foil were used to cover and protect all the parts around the lupus. A red blush appeared in the healthy



skin just around the patch after six exposures, when treatment was immediately stopped for a time. And it is certainly sound advice to give, that *on the first appearance of any inflammatory mischief, no more exposures should be made until it has entirely disappeared.*

"2. In both these cases a *very high-vacuum tube* was used at a distance of from four to five inches from the diseased area. The ten-inch coil was worked from a six-cell storage battery, giving an E. M. F. of from twelve to thirteen volts and six amperes, the actual spark being from eight to ten inches in length. This differs from the plan adopted by some workers, who have used a current of much smaller amperage, with low-vacuum and smaller spark-gap. *There does not seem to me to be any danger in using these stronger currents,* and this leads me to my third point:

"3. *The very few exposures needed to cure these two cases.* The first case had only seventeen primary exposures of fifteen minutes each, and, two years afterward, six exposures of ten minutes each sufficed for the slight recurrence. The second case had altogether ten exposures of ten minutes each. Perhaps the two cases were very suitable for this method of treatment, but the number of exposures are very few compared with other published records of the X-ray treatment of lupus.

"4. The fourth point is the gain to the patient. With this method there is no anæsthetic, no operation, no pain; and all these are most important from the patient's point of view. *The resulting scars are far superior to anything of the kind I have ever seen from any other method.* Both are very soft, almost white, entirely non-adherent, with no tendency to contract—and when situated on the face these points are of the utmost importance. In the second case, situated so close to the lower eyelid, by almost any other means we must have had some draggings in the eyelid which would have necessitated an operation for its cure.

"It seems to me that in future, in all cases of lupus, the X-ray treatment ought to be given a trial before any other methods are adopted. *It ought to be the first thing recommended not only in the bad cases which have been going on for years, but also in the early stages of the disease, when certainly it would have a much better chance of not only arresting, but curing the disease.* I do not think that in proper hands there is any risk at all to the patient from the so-called X-ray burns, while the gain to the patient in avoiding pain and disfiguring operations is very great." (HOLLAND, May, 1901.)

Schonberg reported nine cases of success in 1898 as follows:

"The applications lasted about a half hour each day, with interruptions of different periods in the different cases. In all cases the effects produced follow more or less the same course. The skin first shows a slight yellow tint, which is soon followed by general redness of the affected part. This redness deepens in colors, and with some patients slight itching and pricking sensations are felt, together with

a feeling of warmth. A sensation of a tightness of the skin also follows in some cases, with slight oedema. Excoriation is generally produced, the appearance resembling that of a burn and extends up to the edges of the area protected by the mask. The skin generally heals from the edges toward the centre. As soon as the redness begins to show itself the sitting should be discontinued, and it is important to keep a close watch on the effects produced during the first applications *to avoid a general dermatitis which hinders the cure.* To protect the parts not under treatment a mask of cardboard is used covered with tin-foil, which is more convenient than a lead protection, especially when dealing with the face. The following is a brief summary of the cases described:

"1. Miss M., aged fifty-three, lupus of left cheek, under medical treatment twenty-eight years. Applications of X-rays with intervals for six months.

"2. Mr. R., aged twenty, nose and upper lip. Medical treatment for three years. One hundred and fifty-one X-ray treatments during eight months.

"3. Mrs. R., aged forty-eight, nose and right cheek. Hospital treatment for two years. Applications of rays spread over six months.

"4. A. K., aged thirteen. Nose and upper lip affected for four years. Twenty-eight applications during three months.

"5. Miss B., aged thirty-seven. Suffered from lupus of nose since twelve years of age; forty-six applications during three months.

"6. Miss W., aged twenty-seven. Small spots on both cheeks and forehead. Under treatment for four years previously. Eleven X-ray applications during one month.

"7. Miss M., aged eighteen. Lupus of the face. No previous treatment. During two months gave fifteen X-ray treatments to left side and ten treatments to right side.

"8. Miss K., aged forty-six. Upper lip, nose, and both cheeks affected; under other treatment for twenty-three years. Treated left cheek with X-rays. Sixteen applications, spread over two months.

"9. Miss K., aged thirty-six. Both cheeks and nose affected. Medical treatment for eleven years. Sixty-eight applications of X-rays."

The first cases of lupus and tuberculosis of the skin treated with X-rays by Jones were exposed as follows:

"The face, which was involved from the hair-line to below the lower margin of the jaw, including the entire ear, was protected by a heavy lead plate perforated with a hole to correspond with the area involved. *Exposures at four inches distance were then made with a low-vacuum tube three times a week, séances lasting from two to eight minutes.* The length of the exposure and the frequency of treatment was decided largely by the effect on the skin. When it was too reddened sittings were made shorter and less frequent. A slight dermatitis developed just below the eye and a slight conjunc-



tivitis was also produced, but these troubles shortly passed, and, indeed, were but trifling in the first instance. The maximum intensity of the rays was directed toward the lower portion of the area involved, and this portion improved more rapidly than the ear and upper portion. The same plan was adapted to the situation of the lesion in the second case."

Varney discussed the treatment of lupus by the X-ray in February, 1901, and compared the stimulating influence on the tissues with the similar action and results of Finsen's photo-therapy. He stated, "The results are about the same except that the X-ray is somewhat more rapid in its action, with shorter exposures, and larger areas may be treated at a sitting. *The treatment of lupus by the X-ray is painless, its exposures are of short duration, and the area treated may be of any size or location. There is no scar from the treatment if the exposure is properly conducted.* The time of exposure is regulated by the intensity of the rays, and the results are evident, with much less scarred tissue."

In February, 1900, Hall-Edwards reported the case of a boy fourteen years old, with lupus of the face, lasting eleven years under constant treatment. The disease covered nearly the entire face, and had destroyed a great part of the nose. There was also a patch on the instep of the left foot, and this was treated by exposure to X-rays, with the tube but one inch from the part. Four exposures were made, varying from ten to twenty minutes each. The diseased patch then broke down, leaving an ulcerated surface which healed under careful treatment, and has remained well twelve months. In a second case, a girl had lupus covering the entire face, with the exception of the chin, and also a patch about two inches in diameter on the right arm. The patch on the arm was successfully treated by use of the X-rays. In a third case, a girl who had lupus of the face and right thigh was treated with a successful result.

Geyser\* reported four cases of lupus as follows:

"Case 1.—In a sheet of lead a hole was cut to fit the affected area upon the patient's face, which was about the size of a silver half-dollar. The tube was adjusted at two or three inches from the surface, exposures were made every second day from ten to fifteen minutes. Twelve treatments healed the lesion.

"Case 2.—A small lupus patch, diameter about one inch. Treatment same as Case 1. Improvement noted after seventh treatment. Entirely healed in sixteen treatments. While clinically resembling lupus vulgaris these lesions were neither of them considered to be true lupus, as they healed so easily.

\* Journal of Electro-Therapeutics.



PLATE 165.—Raying Lupus of the Nose. Photographed especially for this work by Dr. L. E. Kelly, of Oakland, Cal., who writes: "Am treating sixteen cases of lupus, or tuberculosis of different parts. Two very bad cases affecting the rectum; one with the floor of the pelvis almost gone. Doing exceedingly well." Note the sheet-lead bent round the face with hole cut for affected nose. It is being tied behind with two pieces of tape to hold it in place, and the operator is adjusting the tube to position. When the lower pair of ribbons (seen hanging down) are also tied have the patient drop his hand to his lap, light up the tube and expose as taught.



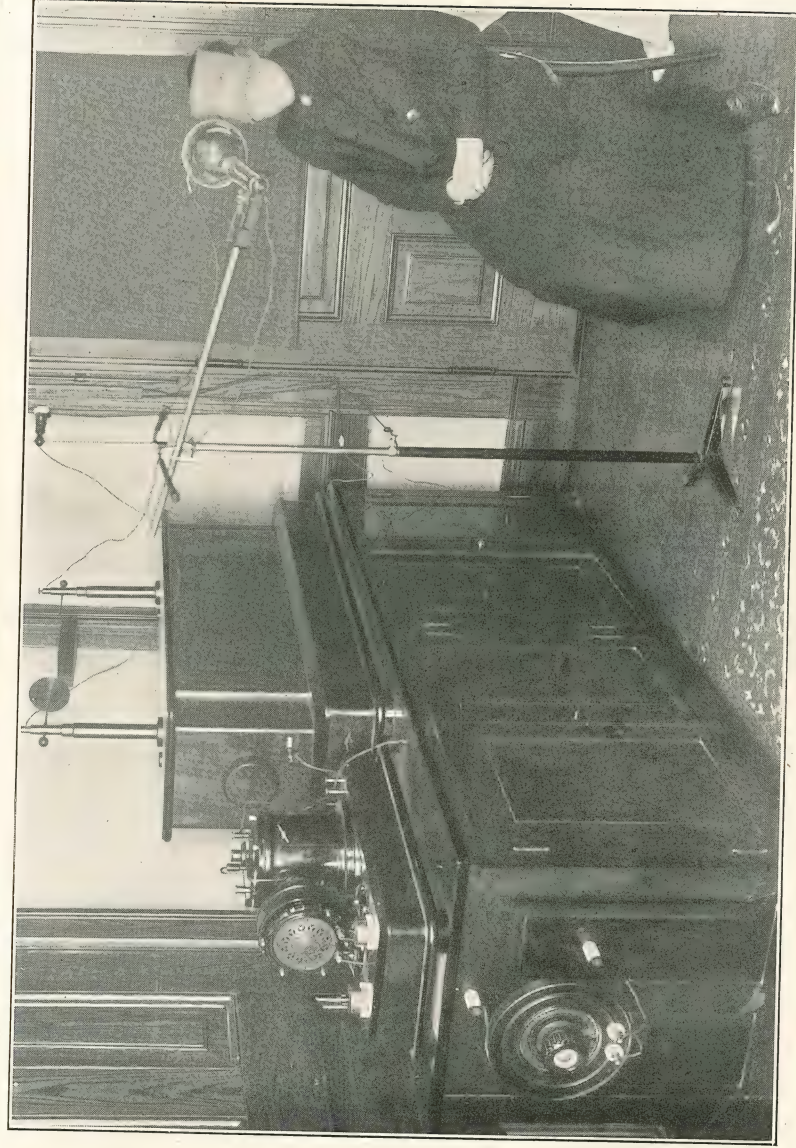


PLATE 166.—"Lupus Vulgaris. One of the worst cases writer has ever seen. The Lupus covered entire face and forehead. The photograph shows method of exposure; lead mask, with opening for forehead, protects hair and eyes. Treatment began May 22; date of last treatment, July 16, 1901. Skin at present time like that of a baby, without a blemish. Tube used, very soft, exposure twenty minutes daily, gradually dropping to three minutes as the 'sunburn' manifested itself." (Blackmar.)

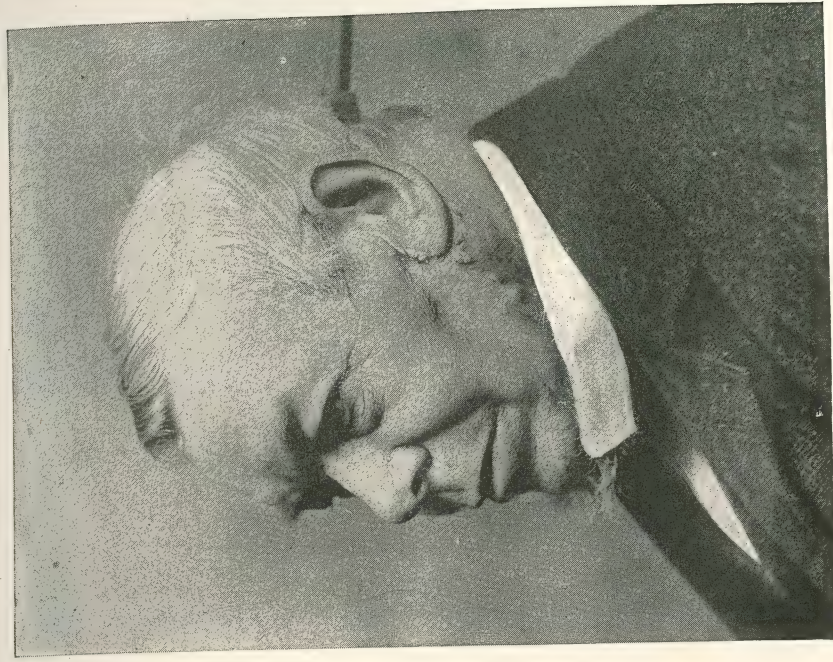


PLATE 167.—Before and after X-ray Treatment. (Rebman, Ltd.)





PLATE 168.—Before and after X-ray Treatment. (Rebman, Ltd.)

"3.—Lupus of eight years' standing, which had resisted various treatments. Diagnosis of lupus vulgaris was substantiated by pathological examination of a specimen taken from the left cheek. Treatment same as before up to tenth séance. A severe dermatitis then developed on the back of the patient's right hand, which he had been in the habit of resting upon the table directly under the tube. The dorsum of the hand was swollen and intensely red, with severe burning pain. In a few days blebs formed very much after the manner of an ordinary burn. The hand was dressed with zinc stearate dry, and kept so with ordinary bandages. Immediate improvement resulted. The pain lessened, swelling disappeared, the skin peeled in large patches, and was at once replaced with sound skin. Four weeks later ridges appeared across all the nails of the affected hand, showing the effect of the trophic disturbance at the matrix. The index finger on the affected hand had previously been swollen, stiff, and more or less sensitive on manipulation, and appeared like a tuberculous joint. This pain and stiffness somewhat disappeared, and even the contour changed. At the tenth treatment little if any improvement could be observed in the condition of the face, but the patient insisted that the *inside* of the mouth and the nose were improving. The patient stated that an obstruction in the nasal passage interfering much with breathing was freed; that the swelling, tubercles, and hard nodules on the inside of her cheeks and lips were disappearing; that she felt as though she had more room in which to move her tongue; and that she could pass her tongue between her teeth and lips, something which for years she had been unable to do.

"At the eleventh séance and thereafter, treatment was changed to the static spray." [For full directions see author's works on "Static Electricity."] "Much improvement ensued even from the first spray treatment. This was continued for six treatments, when a pause of two weeks was made to see if the improvement would continue or lapse. During the first week no change was manifest. About the tenth day the affected area appeared to grow worse, and the patient suffered excruciating pain all over the face, especially in the upper and lower lips. For three days and nights the patient was unable to eat and sleep; the pain became unbearable, and she begged that treatment be resumed. Upon commencing treatment all pain immediately vanished. The patient was able to sleep after the first application of the spray. The spray treatment has been continued twice a week, or less, and at the time of this report was not completed.

"Case 4 was a mild one. The patient objected to microscopic examination. Rapid improvement was made under the static spray, and after the sixth treatment the patient left for the country."

"In a discussion of these cases a physician present related that he had recently a case of lupus, a chronic case, which had been treated by a number of physicians, but as the patient lived out of the city he could not attend for X-ray or electrical treatment. From





PLATE 168.—Before and after X-ray Treatment. (Rehman, Ltd.).

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its history and symptoms a diagnosis of lupus was made. 'Three weeks ago I suggested to the man that he take a simple magnifying-glass and concentrate the sun's rays upon it three or four times a week, continuing the treatment for four or five months. When I last saw the case the growth had apparently ceased, and there was no further invasion of the tissue. I have just received a letter, saying that the growth had practically healed, had dried up, and that the patient felt he was well, but would continue the treatment another month to make sure.'

A case of lupus of the face uncured and under further treatment by the X-rays was reported by Dr. Hills Cole.

"My patient had been in the habit of steadying the lead-plate protector with his hand during the treatment. Some time ago he noticed a roughness of the finger-nails of the hand that touched the plate. The distal phalanges of the fingers came above the plate. Marked rugæ appeared in the nails, and subsequently the old ones fell off and were replaced by a new growth." (Avoid this.)

Pusey contributed the following to the study of lupus:

"The patient, a married woman aged thirty-eight, was referred to me May 8, 1900, with a diagnosis of lupus and for treatment with X-rays. The condition at that time is shown in the accompanying photograph, Fig. 1, which I took when I first saw her. The extent of the disease on the left side of the face and the neck is indicated in the photograph. It also extended over on the right side of the chin and up on the right cheek beyond the angle of the mouth. This entire area was covered with lupus ulcers and unhealthy scars. The ulcers were the typical flabby, soft, indolent ulcers of lupus covered with reddish-brown crusts. The scars were thick, red, band-like, and very disfiguring. The scars were most marked under the chin, and they were sufficiently rigid to materially interfere with motion. At many points in the scars there were recurrent ulcers. Typical 'apple-jelly' tubercles of lupus were easily demonstrable in any part of the diseased area. The point of greatest activity of the lupus was an area with a diameter of perhaps two inches around the left angle of the mouth. The ulcers involved the mucous membrane of the lips at this point, but no lesions were found within the buccal cavity. There was no evidence of tubercular involvement of the deeper structures. There were no deep sinuses and no tubercular glands. The case was, in short, a lupus and not a scrofuloderma.

"I have sections made from a piece of tissue taken from the border of an active ulcer. These sections show the structure of tuberculous tissue. Tubercle bacilli were found in this tissue by me, and independently in other sections by Dr. Roehr, of the Columbus Laboratory. I was fortunate in having the case seen by Dr. H. G. Anthony, professor of dermatology in the Chicago Polyclinic, when it first came to me; he agreed in the diagnosis of lupus.

"While the lesions were freely ulcerating, the surface was covered with boric-acid vaselin, and in the morning before the treatment by X-rays the ulcers were lightly cleaned with cotton-sponges wrung out of a weak bichlorid solution. The ulcers, however, were never washed with bichlorid solution, and the case has had no other local treatment. The patient has had no internal treatment of any kind until within the last month, and then only a pill of reduced iron, arsenious acid and strychnin, t. i. d.

"Treatment was begun by exposure to X-rays on May 8th, and was continued daily, except Sundays, until May 26th. By May 24th many of the lesions were clearing up and beginning to heal. May 26th the exposed surfaces showed some reaction from the effects of the rays; the lupus tubercles were brighter in appearance and the borders of the ulcers redder. Treatment was discontinued until June 4th, by which time the reaction had almost disappeared. The treatment was continued from June 4th until June 21st, daily, as before, when considerable dermatitis developed. This dermatitis was confined to the diseased tissue and did not involve the surrounding healthy skin which had been exposed to the rays. At this time the ulcers were healing rapidly. The treatment was discontinued until July 2d, when reaction had entirely disappeared and almost all of the ulcers were healed. From July 2d till August 10th the treatment was continued, not daily, but with a few intermissions of three or four days as the condition of the face indicated. During this time there was gradual improvement in the condition, the remaining ulcers healing, tubercles being absorbed, and the entire surface becoming covered with healthy scars.

"By the latter part of July the left side of the face showed few traces of the disease. The diseased area on the right side, however, which from the manner of making the exposures had received less of the effects of the rays than the left, still showed lupus nodules and open ulcers. Accordingly, additional exposures were begun directly over this area on July 30th and continued daily in a maximum amount until August 10th. Under these extra exposures the lesions immediately began to improve and by August 10th had entirely healed.

"On August 10th treatment was discontinued, because of my going away. At that time the only evidence of lupus that I could find was at the angle of the mouth, where there was still a focus of disease. On September 13th the patient returned; there was then no evidence of disease at any point except at the angle of the mouth, where the tubercles persisted. Treatment was resumed with exposures over the left angle of the mouth. September 20th the tubercles on the upper lip were breaking down and an elliptical ulcer the size of a little-finger nail had developed, which within the next few days began to heal. On October 2d some erythema over the exposed area had developed and treatment was given up until October 8th. By October 8th the last lesion had disappeared. From October 8th to



date the patient has had daily exposures on the left side of the chin and on the neck under the chin.

"These exposures have been continued for two reasons: 1, *the old keloid-like scars had shown under the exposures great improvement in flexibility, softness, and color*, and it was desired to carry this effect as far as possible; 2, to destroy any concealed lesions still present. Since October 8th I have not been able to find any evidence of disease.

"The results of the treatment are indicated in photograph, Fig. 2, taken November 10th. There remain now, excepting the scars, no evidences of the disease; and even should more or less recurrence of the lupus take place, I believe the results may still be called *extraordinary*. Attention is called to the character of the scars. The only thick ones left are those which were in existence before the treatment began, and they have become less prominent, much softer and more pliable. The scars which have taken the place of the ulcers present when treatment began are soft, thin, flexible, and white, and are as healthy looking as they could possibly be. At the beginning the scars on the neck interfered very considerably with motion; now they interfere scarcely at all.

"*Certainly none of the usual methods of treatment by surgical means could produce such a result.*"

A case of lupus of fifteen years' duration was reported by Smith.

"Frank Nichols, aged about eighty, consulted me for an ulceration of nose and face which was involving his right eye. I found he had a lupus patch which extended from the left side of nose, going over the bridge and involving the right side of nose and inner canthus of right eye and the inner thirds of the lids, together with the bulbar conjunctiva. About fifteen years ago he was slightly injured by a chip striking him on the nose, breaking the skin. It never healed over, but slowly increased in size, notwithstanding he had been treated by a score of physicians, a few skin-specialists, and numerous quacks. About a year ago it invaded the eye, since which time it had progressed more rapidly in the mucous surface. There never was much pain; it bled occasionally and disfigured him much. His general health and family history were good. No specific taint was elicited. I made a mask for the face of sheet lead, cutting a hole for the nose and diseased part of right eye, and with this on, exposed him about every fifth day for twenty minutes at a time, the diseased surface being placed about two inches from the light. He received in all twelve treatments. No medicine whatsoever was allowed. He was using applications of vaseline at first, but that was denied him. Marked improvement commenced after the second treatment, and was not interrupted until the sore was completely and entirely healed. After the second treatment healthy granulations appeared and healing was remarkably speedy. There was no burning from the light, or any other unpleasant symptoms complained of,



PLATE 169.—One of Dr. Holland's Lupus cases before treatment. The next plate shows the case after treatment. (Rebman, Ltd.)





PLATE 170.—Dr. Holland's case of Lupus after treatment. (Rebman, Ltd.)



PLATE 171.—Lupus case before and after treatment. (Rebman, Ltd.)



except a slight headache and a decided 'crawling sensation' in the sore after the first two treatments. The cicatrix has produced a slight ectropion by everting the inner end of the lower lid, and has drawn the upper lid down and in, but vision is normal."

*Case of Lupus Erythematosus.*—"Mrs. G., aged forty-three. Duration of lesion eight years. First X-ray treatment April 1, 1900. Face protected with lead mask with hole cut to fit lesion. Used high-frequency coil and medium-vacuum tube. Exposed for twenty minutes twice daily for three days; then ten minutes twice daily for six days; five minutes daily for three days; then three minutes daily for three days, a total of fifteen days' treatment. She remained for nearly a week after that to enable me to watch the slightly developed dermatitis, which was at no time severe. She returned home with a little color over the lupus area, which was left from the burn, and it was thinner, cleaner, and in better condition than after the first scarification. One week after her return home, word was received that her face had entirely healed—nothing remaining to be seen except a few little scars, probably the result of the scarification. Four months have now intervened, and her letter of July 28th states: 'I was never better, and my face is certainly well.'"

*Case of Lupus Vulgaris.*—"Mrs. H., aged thirty-eight. Coughs a great deal. Examination of lungs, roughened inspiration over whole area of left lung, few moist râles, sputum not examined. Six years ago was in fair health. Slight hard pin-point elevations appeared upon the middle of left cheek, gradually increasing in size with tendency to aggregate and coalesce. Several ulcers formed in the mass, after a period of a month the whole area enlarging, involving the cheek, soon presented a hideous appearance. The discharge was so vile that the patient was almost driven to suicide. Her mental condition need not be described. This patient began treatment February 5, 1901. The same procedure as with the Lupus Erythematosus case, excepting the use of the low-vacuum tube and prolonging the treatment on the fourth, fifth, and sixth days to thirty minutes twice daily, carrying her to the sunburn point, then dropping the time of treatment to five or three minutes in duration, as I deem wise. In this case I produced a severe burn in the centre of the large ulcer, and two small points near it. These discharged more profusely than ever. One strange feature in connection with this was that after the fourth treatment there was practically no odor.

"After the third week of treatment the large ulcer began to heal, leaving the two small ones discharging. By the middle of the fourth week the two small ones stopped discharging and healing continued rapidly. At this point I gave the patient predigested food and Gude's Pepto Mangan with good results. Five months have gone by without return of the lesion.

*"Ulcer of Leg.*—Male with specific history. Claimed to have recovered from syphilis after three months of medical treatment.



Two years later ulcer appeared on the left leg. No varicose condition present or history of injury.

"Treated ulcer with X-rays for scant two weeks. After the first week the healing process was quite marked. A week after stopping treatment it was almost healed. Five months have elapsed and the patient is well." (BLACKMARR, August, 1901.)

On May 21, 1901, a visiting physician stated to the author that he had himself "cured" three cases of lupus vulgaris with X-rays, and another physician in his city had treated fourteen cases and cured them all. *He regarded X-ray therapy "as a specific for lupus." He also "used it for old ulcers and varicose ulcers with good results; also for epithelioma with fine results."* He puts the tube at first five inches from the part. Exposes five minutes daily at first, and each day gradually puts the tube further and further away till it is ten inches off. He watches carefully for irritation, and if the part whitens or changes he stops treatment for a few days to see what effects appear. If all is well he resumes treatment as before. Usually the hair falls out when the head is thus treated, but it grows in again. He does not know whether the lead protection is needed or not. He "uses it because all do." He carries a wire from a loop in the lead to the ground. Some do not ground the mask. If it is used at all *it should be grounded the same as a Static electrode.*

The following valued communication was written the author by Dr. G. G. Stopford Taylor, of Liverpool, England, to whom fraternal acknowledgment is here made:

"I use masks of lead-foil in which openings are cut a little less in size than the part to be rayed. Unless they are close fitting the rays penetrate beneath the margins of the openings and produce an erythematous zone beyond the area of the disease to be acted on. To obviate this I have found it advantageous in some cases to bind a large piece of raw cotton firmly over the openings, including that portion of the mask surrounding them. The pressure of the raw cotton has also another beneficial effect, as it renders the diseased area more or less anæmic, and this facilitates the penetration of the rays. This so-called X-ray erythema appears unexpectedly and may prove a troublesome complication, for if treatment is not at once suspended it continues to spread and naturally causes much anxiety to the patient and annoyance to the operator. Fortunately, I have never seen it cause more than four or five weeks' delay. The cases in which it is most likely to occur are in very superficial forms of disease, or over bony prominences, or, where there is an absence of fat as in the eyelids. At the commencement of treatment I place the tube a hand-breadth from the disease, and, should no improvement occur after a few exposures, I lessen the distance. I consider the thera-

peutic effect of the rays as a form of stimulant the like of which we have never seen before; for, while they have the power of producing epithelial growth and the absorption of inflammatory products they also have, if used unskilfully, an escharotic action upon the tissues. Deeply infiltrated cases of lupus, rodent ulcers, and epithelioma, however, have proved remarkably tolerant of the action of the X-rays."

**Combined X-Ray and Finsen Methods in Lupus.**—A combined method of treatment has been carried out by Morris and Low, especially applicable to difficult cases of lupus of the face and cheek implicating interior tissues. They remark:

"This combined method has been in use at the Finsen Institute, but not systematically. Its rationale is that as the Finsen rays cannot be brought to bear on any other than plane surfaces, the X-rays, by virtue of their power of penetrating soft tissues, may be used to act on the mucous membranes, however complicated their arrangement and situation. A good instance was a case implicating the interior of the nose. A mask was made of card-board and lead-foil, and applied to the face, with a hole cut in it corresponding to the external margins of the lesion. A six, or seven-inch spark current was employed, and a series of exposures was made, each lasting ten or fifteen minutes, until mild dermatitis was produced; then an interval of some days was allowed. After about fifteen or sixteen exposures a distinct improvement was manifest. The reaction produced was similar in kind to that of the Finsen System, but the dermatitis which was set up was said to be less marked in diseased tissues than in the healthy ones. Another case was shown in which, before treatment was commenced, there was absolute obstruction of the nose, but after a number of exposures the ulceration entirely disappeared, and nasal respiration became quite comfortable. Another case was referred to, in which X-rays, directed through the open mouth, had very favorably influenced lupoid ulceration of the palate and gums."

The advantages of combining exposures to the Finsen Method and X-Rays in alternation, were stated to be that the necessary daily exposure was shorter, and that it was much less costly, one method supplementing the other; and results were sufficiently good to encourage perseverance with the combination. (See Section on Photo-Therapy.)

**Technic for Raying Lupus.**—*Facial cases.*—Take pieces of sheet lead-foil large enough to cut off the rays from the entire head and chest. Cut a paper pattern to correspond with the area of the lesion as exactly as possible. Then *cut out the lead one-eighth inch smaller at the cutaneous margins.* Make two small holes at the sides for lace strings to tie back of the head, and if the nose does not participate



in the treatment cut an outlet for breathing. The cause of many reported ill-effects on normal margins of cases treated has been:

1. *Too large a hole* in the lead protector. Or (Plate 174),
2. Failure to fit the edges of the hole in close relation with the lesion. Or,
3. The use of tin-foil or other metal in too thin layer for the given radiance. Or,
4. Disregard of the axial focus of the rays. Or,
5. Indirect contact between the edges of the metal and the dry and healthy skin.

Avoid all these faults of technic. Keep *the eyes closed* during treatment. Sit the patient in a chair in front of the tube. Bind a layer of surgical cotton over the entire lesion, making it thickest at the margins. Then tie the lead mask in position. If the breathing outlets are not in the field of treatment bend the lead out in front of the mouth to admit air. Press the marginal opening as closely as possible down to the covering of cotton. Next level and focus the anode so that *the axis of the rays will coincide with the centre of the lesion*. Use a tube giving not less than a good radiographic degree of radiance. Regulate the electric current to an even action of the tube. Place the surface five inches from the tube-wall. Then hook a grounding wire from a gas- or water-pipe to a convenient tie-hole of the mask and commence the exposure. Avoid the early rule of long daily exposures. Treat the part ten minutes, three times a week, at first. Watch for evidence of over-action. Lessen or increase the dosage as individual indications arise, according to suggestions throughout these chapters. Do not stop final treatment before full restoration is accomplished. An apparent cure may develop after such treatment ceases, but recurrence is likely. Manage the ordinary care of the case on rational principles. Those who have Static machines will find great assistance from special sprays as alternate treatment. (Plates 165, 166, 174, 175, 176, 179.)

*Lupus patches on other parts of the body.*—When neither protection of the hair of the head and eyes calls for special care the sheet of lead-foil may be prepared in the same way and tied on the part with the same care, but can be much less extensive, and with the aid of the diaphragm the field of rays allowed to reach the part can be limited very nearly to the area of the lesion itself. Instead of sitting the patient in a chair the location of the lesion will often suggest a recumbent position. The remainder of the treatment is the same as described. Do not omit internal prescribing for the general condition of the patient when indications exist. (Plate 164.)



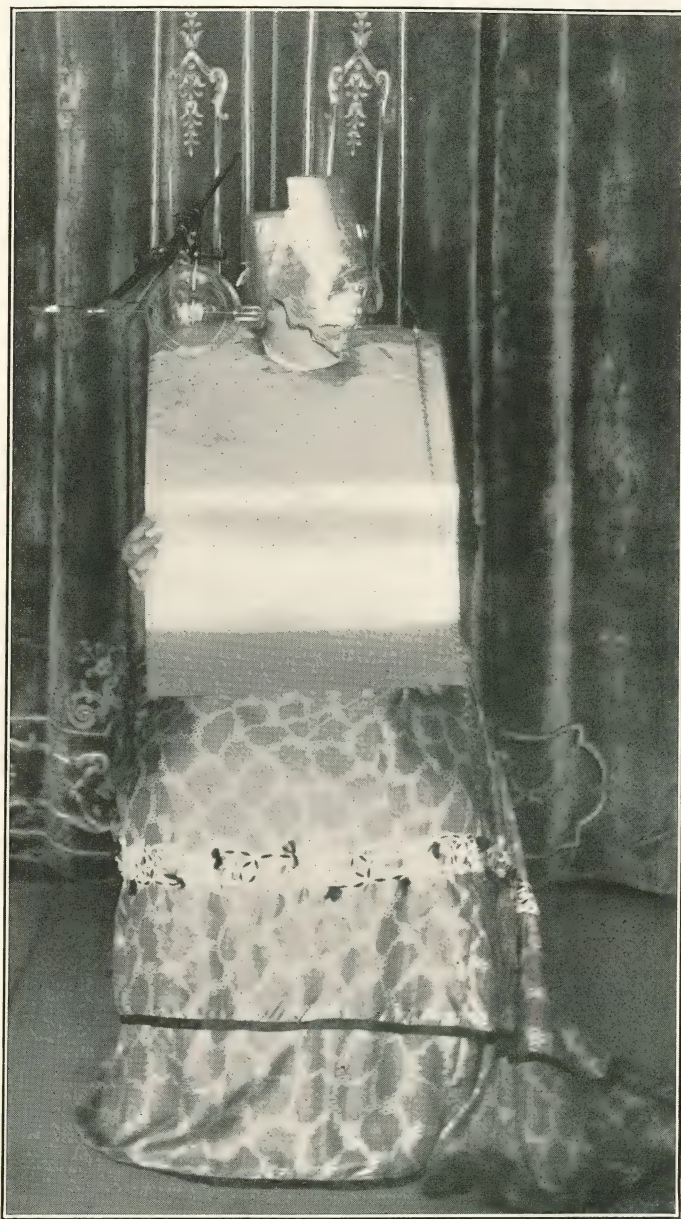


PLATE 173.—This plate shows one side view of foil-covered mask with space cut for treatment of side and chin whiskers on woman's face. The front shield protects the chest and shoulders during the exposures. The patient is seated on a revolving stool during treatment, the mask and shield grounded by the chain seen at right, the tube placed with its wall six inches from the tissues, and a total exposure of twenty minutes is divided upon the four areas of the two sides of the face and neck by turning the patient on the stool. Use a medium tube. Use the least current that will excite it properly. Repeat treatment three times a week. Watch for the first sign of irritation, and then wait till it subsides. Permanent depilation requires patience and careful treatment.

## CHAPTER XL

### X-RAY REMOVAL OF SUPERFLUOUS HAIRS

#### RESULTS AND METHODS OF TREATMENT.

**Temporary and Accidental Alopecia from X-Ray Exposures.**—It has happened in quite a number of cases that an undesired loss of hair followed either radiographic or therapeutic X-ray exposures about the head. It has grown in again in all reported cases. The *temporary* loss of hair from exposures made for other purposes is quite a different matter from treatment directed especially and persistently to the atrophy of the hair follicles. Clinical evidence thus far shows that *permanent* depilation is only brought about by use of the X-rays in a methodical manner. To those who meet with the undesired by-effect of alopecia in some other employment of X-ray therapy (its occurrence in radiography being now extremely rare) it is reassuring to feel certain that the lost hair will be restored. But, on the other hand, this fact lends uncertainty to the treatment of objectionable hypertrichosis. Up to the present time many practitioners have not distinguished between the management of the two cases, and without reason assume that permanent effects are impossible. For instance, a Western physician lately wrote to a medical journal as follows:

"For some time I have been seeing reports of the use of the Roentgen-ray for the removal of hair from the skin, all advocating this form of light-therapy for the purpose. My limited but very satisfactory experience in this line has led me to a conclusion opposing the opinions of the writers of the above-mentioned reports. I once made several long fluoroscopic examinations of a young boy, and also made a skiagram; another operator did the same, and some time later it was noticed that the hair on one side of the head, in a strip about half an inch wide, came out. It returned completely after a time. For about a year I was making various experiments with the X-ray, making many skiagrams of my left hand, and also using it as a test-piece in fluoroscopic work; a typical X-ray dermatitis resulted, marked by itching papules, swollen, cracked, oedematous skin, and loss of the hair from the back of the hand; I stopped using



my hand in the way, and after a while complete recovery took place; there is just as much hair on the back of this hand as is on the other one."

In many cases it is important to know that a return growth may be confidently expected, yet it is equally important to observe that temporary effects are the result of temporary treatment or exposure, while permanent effects, when these are directly sought, are the result of the reverse of temporary exposures, and are secured only by long lasting and definite treatment directed to the end in view. That satisfactory results can be obtained has been conclusively established by many workers in different parts of the medical world. We will now consider the specific treatment of hypertrichosis and describe the technic.

**Permanent Depilation by X-Rays.**—Scattered profusely among the rich treasures of information in the two preceding chapters are many important allusions to this subject. The reader may study them in their proper context. The abundance of related experience permits us to abridge this chapter to a single further contribution—a study of dosage offered by Wood. When read in conjunction with Dr. Sharpe's exceedingly valuable study of the effective treatment of hypertrichosis in our chapter on skin diseases there will be little to add save the *technic*.

"A woman aged twenty-two consulted me in November, 1898, on account of a considerable overgrowth of hair on the face. The history given was that fourteen months previously one inferior turbinate bone had been removed, and that about three months subsequently the hair on her face, which had not been excessive, took on active growth. During the two or three months before her visit it had become conspicuous and excited comment. She was a healthy-looking fresh-complexioned brunette; bodily functions regular; nothing remarkable about the hairy scalp; hair on body said to be normal. On the upper lip, from a point half an inch from the middle line, and extending outward on each side for three-quarters of an inch, there was a moderately close growth of dark, rather thick hairs, mostly about a quarter of an inch long. In front of the ears there was a slight excess of hair, and this growth continued on each side, down to the angle of the jaws, the length of the hairs increasing to this point. On the chin the hairy growth was most conspicuous and disfiguring. From the point extending one inch upward, three-quarters backward, and one inch transversely, there is a groundwork of closely set down, and in addition numerous thick dark hairs, from one-eighth of an inch to one inch in length.

"It was decided to first treat this area, and to begin with the front part of the chin, the rest of the face and neck being protected with

a lead-foil mask. The sittings took place, when possible, six times a week, and the duration of each sitting was ten minutes. The anode was between six and seven inches from the skin. The primary current was five amperes, and the number of interruptions between 250 and 300 per second. After fourteen exposures it was noticed that the darker hairs had lost some of their lustre, and a week later there was an obvious lessening in their number. The hairs shed were brittle and pale in color, with atrophic bulbs, while microscopically the normal striation was indistinct and the medullary substance appeared to be collected into separate nodes, with clear intervening spaces. During this period occasional reddening of the skin was noticed. Treatment continued till forty-five exposures had been given to the point of the chin, when the whole of the thick and downy growth had disappeared, except nine hairs, which remained at least a week after the total removal of the others.

"Mechanical interference having previously been avoided, it was now desired to ascertain the condition of these residual hairs. By making gentle traction on one it was found that it was really separated at its bulb, which was deeply placed, but was held by a more superficial part of the root-sheath. Therefore, the rest were left untouched. It was now clear that the object aimed at had been attained, and as the skin was somewhat reddened treatment was ordered to be given thereafter only to the under surface of the chin. This message to assistant miscarried, so that the front received a few more exposures, and a sharp dermatitis ensued, which, however, speedily subsided under simple treatment. Twenty exposures were also given to the under part of the chin, and ten consecutively to the cheeks. The result some eight months after cessation of treatment can probably be safely judged, since for three months there has been no change in the condition. The front of the chin, which received more than forty-five exposures, remains quite free from down and hair. The under surface, which had twenty exposures, is cleared of down, but within three months after suspension of treatment a few thick hairs returned. Their number, however, has not since increased, and they are so sparse that electrolysis is indicated for them. The cheeks, which had only a small number of exposures, temporarily lost their hair, but it has grown as before.

"It would seem then that for depilation ten short exposures are useless; that about twenty exposures will clear the ground for electrolysis, while some number between twenty and fifty will probably result in permanent depilation. It is to be expected that this number may be reduced by further experience, so that a treatment which *neither pains nor disfigures* may take its proper position in practical therapeutics."

**Technic for Facial Depilation with X-Rays.**—For small local superfluous hairs limited to one area cut out a lead mask as for a case of lupus and proceed in the usual manner. For more general hairy



growths get a common "false face," such as are sold for about fifteen cents at toy stores. Fit it on the patient's face, and, with a lead pencil, mark on the outside of the mask the areas from which the hairs are to be removed. Take off the mask and cut out the parts as marked.

Next glue pasteboard wings at the sides and on top of this mask to extend beyond all tissues and normal hair needing protection. When dry and secure cut pieces of the "tea lead-foil, No. 1," mentioned in our chapter on Screens, of which every operator should keep a stock, and mould them on the outside of the pattern built up by the mask and its wings. In holes in the back insert two tie-strings to secure it on the head. Make a breathing opening for the nose and double the thickness of the foil over the parts that will be most exposed and need most protection during treatment. See Instruction Plate No. 173 illustrating device complete.

Next take a sheet of common card-board about two feet long and eighteen inches wide, cut out a half-circle at the top to fit around the neck, and cover the outer surface with a layer of the foil glued at the edges, to shield the bony prominences of the shoulders, the chest, hands, etc., during exposure. Once made and adapted to a patient these shields will last indefinitely and serve for all treatment the case may need. Next proceed as follows:

Connect a medium tube giving ample radiance in a holder which will permit free movement of position when the tube is in action. Seat the patient on a revolving chair in front of the tube and close to it. Have the tube ready to start into action and then tie on the face-mask; place the chest-shield in front of the patient so as to protect all necessary parts; have the patient support it by her hands held low down at the sides out of reach of the rays; hook the grounding chain over both shield and mask, and turn either side of the face toward the tube to begin the treatment. Place the tube so that the axis of the rays is square with the exposed area of the face, with the tube-wall about five inches from the skin. Turn on the current and light up the tube. The two sides of the cheeks and the two sides of the chin and neck may be considered four areas to successively bring into the direct field of the axis of the rays, for oblique rays are so much less effective that they do not constitute treatment. Have the patient first hold one side of a cheek steadily in the field of rays for five minutes, then without stopping the tube direct her to turn the face so as to bring one half the chin into the field, and, while raying this region, shift the level of the tube as needed to reach all parts, and also have the patient raise or lower the head and chin according as the under or outer surface is being treated. In five

minutes make another quarter turn, and finish a total séance of twenty minutes with the rays on the last area.

Keep the tube evenly excited all the time, and turn the patient with care against her getting too close to it. Some shifting of the position of the tube is required to reach under the chin. One level will not treat all the areas. Especially avoid letting the patient drop the chin carelessly too close to the tube, as this region has thin tissues which irritate rather easily. Also note that a stiff high collar, such as some wear, will be rubbing on the under surface of the neck all the time, daily, and create a predisposing condition of irritation. This will easily tan a brown or get up an erythema. The safeguard is in maintaining distance and not letting the tube get up to one or two inches from the skin. At the close of the sitting remove the tube out of the way, take off the mask and shield, and, if any irritation arises, remove it with a sedative application. This is usually an emollient ointment prescribed by the physician, but may be the sedative static breeze as taught by the author.

Repeat exactly the same exposure every second day till either some slight tanning effect, or reddening, or other sign of action appears, and then stop all treatment for a week to observe the cumulative effects. If no action appears visible after, say, ten treatments stop anyway. There ought to be no irritation with a careful dosage, and the patient may think that nothing is being accomplished. She must understand, however, that safe action is slow action, and results will take time.

After the week of tentative rest resume treatment as before, and give another series of about ten treatments with a week's rest at the end for observation. If more than merely nominal discoloration of the skin has occurred increase the distance of the tube two or three inches. If any sign of erythema appears reduce the length of each exposure after a rest till all irritation disappears. When the skin begins to feel somewhat stiff and sore, and, finally, when bleaching of the hairs can be observed, yet having avoided dermatitis, the first stage of treatment is nearing an end. Continue sittings till most of the hairs fall out naturally as the patient rubs the face with the towel after washing as usual. Do not pull out any hairs forcibly at any time. At intervals of about one month make a series of three or four exposures to abort any tendency to return. Gradually lengthen the interval as time shows the results to be complete, and, finally, stop all treatment with instructions for the patient to report for a few sittings if in future time any new hairs appear.

Regulate the current to work the tube well without an excess of



electrical action. Do not force a tube after it becomes resistant, but take another and let the first rest. After the early series of exposures watch for the appearance of incipient itching, or redness, or any sign that the skin has been acted on. The irritability of the tissues which discloses these symptoms is controlled in the following manner better than by any emollient unguent. Remove the tube after the depilation treatment and seat the patient on the static platform connected by a metallic contact with the positive prime conductor. Ground the negative pole to the water-pipe or gas fixture. Ground a polished brass-point electrode. Start the machine into just sufficient speed of the plates to give a strong breeze without liability of spark. As the plates begin to turn, quickly bring the point of the electrode up to within two inches of the bare surfaces of the face which have been X-rayed. Gently move the breeze over all the parts till they are cool, soothed, and refreshed. Five minutes is sufficient to give complete relief. When the condition has advanced to the pains, stiffness, and other mild symptoms described by various writers in previous chapters, this sedative application will delight the patient by almost magically restoring the feeling of the face to normal. It can be applied after each X-ray exposure when needed. The method must conform to the author's teachings in order to secure the effects. An irritating spray must not be used.

## CHAPTER XLI

### CUTANEOUS CANCER AND RODENT ULCER

#### REPORTED RESULTS OF X-RAY THERAPY. METHODS EMPLOYED.

A VERY large number of medical men are now engaged in testing the effects of X-ray discharges on *superficial* forms of cancer. Few final reports have yet reached print. Palliation may encourage the patient, yet deep *malignant* disease has not won its name without reason, and if X-rays prove less potent than some now hope, it will be cause for thankfulness if they improve upon the knife. That they are demonstrating an important action which deserves the fullest development and test cannot be doubted. From private sources we hear of remarkable results now in progress in various parts of this country in cases of cancers and sarcomas, and, though conservatism awaits on time for the announcement of any radical conclusion, we think that the published selections here presented will be deemed *under-estimates* of X-ray value by workers with the matured technics which the future has in store. Statistics and reports of the past regarding the X-ray treatment of cancer should not be accepted as the measure of future results. Some cases were treated too timidly, some too actively, some stopped treatment much too soon, some practitioners had not yet the experience to direct the action, and, perhaps, most men who look back to their earlier cases now feel that they know how to do better. Many partial failures with a new remedy are due to faults in method, and with an intelligent selection of the case, a skilled management of the treatment, and the essential persistence in treatment till not only surface indications have been met, but the patient has really had all the benefit that can be given him, we shall in future see greater success and more permanent effects than many now suppose possible. The author is convinced that many operators have failed to employ adequate dosage and sufficient persistence. Dosage is as important in all forms of physical therapeutics as it is in drug therapeutics, and when administrations can be based on scientific dosage results will improve. As there is practically no risk whatever in attempting to relieve and prolong life by this method, we



urge the careful study of this chapter by all physicians and surgeons and a judicious comparison with the results of operative interference.

We first submit for study Chamberlain's explicit report of May, 1901, on the "X-Ray Treatment of Cancer" in his practice.

"The object of this paper \* is to report a few cases of cancer treated with the X-ray, and to make a few deductions therefrom, in the hope that others may be influenced to continue the experiments and assist in robbing one of the most dreaded diseases of some of its horrors.

"The following cases were treated with the ray generated in a Monell tube connected with a ten-plate Wimshurst Static machine. Tubes of varying vacuum were used, from one so soft that the ray could barely penetrate the hand, to one so hard as to give a ray of the greatest penetrating power.

"Most of the treatments, however, were given with the highest vacuum or so-called hard tubes. The distance of the tubes from the parts treated varied at times from three to ten inches, and the time of exposure from three to ten minutes. *The best results were obtained with high tubes at a distance of four to five inches, treating for six minutes at each exposure.* The frequency of treatments varied from daily to twice a week, until some effect was noticed. This effect, in the case of an open sore or mucous surface, consisted in the appearance of an exudation, grayish in color, which, when stripped off, left a bleeding surface. In the cases of a skin surface this effect consisted in the appearance of a redness which is described as being from a dermatitis; in none of my cases, however, was this so-called dermatitis accompanied by any itching or burning sensation. The effect referred to did not appear before the eighth day following the first treatment, in some cases it was delayed for three weeks; the average, however, was about the tenth day. As soon as either exudation or redness appeared the treatments were reduced to three or four a week.

"As far as possible the healthy tissue surrounding the growth was protected by lead rolled very thin, or four thicknesses of tin-foil such as is used by florists. When hypertrophic granulations were present they began to melt away about the time the exudate appeared, and a healthy healing line usually appeared within a month.

"When hairy parts were exposed the hair fell out with one exception; but in all cases where sufficient time has elapsed, the hair has grown again. In cases of *open* secreting surfaces, the secretions were rapidly lessened; but in one case, where the deep cervical glands were septic the formation of pus seemed augmented by the application of the ray, from which I argue that the ray is not germicidal.

"Case 1.—A physician, seventy-five years old, who reported his own case. He had an epithelioma which began as a scale on the skin

\* Journal of Electro-Therapeutics.

between the angle of the mouth and the wing of the nose on the right side. Finally there followed a deep open sore, which refused to heal and was removed by operation. A similar growth started at the wing of the left nostril, which increased, as did the first one, and was also removed. This one returned and was again removed. It returned again, however, and ate away almost half of the nose, including the cartilaginous portion of the vomer, a portion of the upper lip, a large hole in the left cheek, which extended to the malar bone and was very near the left eye. It invaded the mouth and ate away a portion of the gums on the left side, so that it was impossible to masticate solid food. The entire sore surface, including the inside of the nostril, was covered with easily bleeding fungous granulations. After about six weeks of treatment all pain and burning had ceased, and there was positive evidence of healing. In four months' time he had gained about twenty pounds of flesh, was able to eat solid food again, and the sore was healed with the exception of a small space over the edge of the vomer and on the maxillary bone above the incisors. At these points the cicatricial tissue was so thin and the blood supply was so limited that the surface seemed ready to break down. Occasional mild treatments were continued for some weeks till this surface healed over. My last reports from the doctor, some four months later, were that he remained well, had resumed his practice, and had bought himself a Static machine for the purpose of treating similar cases.

"Case 2.—A man of sixty-five years with an epithelioma on the left temple, and involving the left orbit, having destroyed the lower eyelid and eaten a hole into the nostril at the site of the inner canthus. This patient had submitted to several surgical operations and the application of numerous cancer plasters. I was compelled to remove the eyeball to save the other eye, in which sympathetic ophthalmia had begun. The accompanying photograph, marked Case 2, shows this patient's condition as he came to me, and also his appearance after the sore was healed. The white patch on the side of his nose is a piece of cotton placed there to cover the hole in his nostril. The patient remains well to date also.

"Case 3.—A woman, aged fifty-four, suffering from an inoperable cancer of the cervix. She had an offensive leucorrhœa, was anæmic from hemorrhages, which had been recurring for the last six months previous to her consulting me. She had passed the menopause one year before the first hemorrhage occurred. Her husband, a physician, was giving her morphine to relieve her pain.

"*Ten-minute treatments were given daily through a Ferguson speculum.* After eight treatments the characteristic exudate began to appear on the cervix, the offensive discharge was much decreased (though there had been no change in the local measures used), and she did not have any more hemorrhages from that time on. After the twelfth day she had treatments three times only per week, and of five minutes' duration, which was increased in a few days to seven



and one-half minutes each. Her pain was very much relieved, and the abdominal distention disappeared. She unfortunately had the morphine habit, so that the opiate could not be withdrawn at once; but her husband was withdrawing it gradually. After two months and ten days' treatments had been given, and we were very much encouraged by so many favorable signs, our patient suddenly developed signs of cerebral embolism, from which she succumbed about two weeks later. She had no renal or cardiac lesion, and a question still remains whether the source of the embolism was in the uterus and from too rapid disintegration of the cancer caused by too vigorous treatment, or whether the hypodermic needle struck a vein.

"Case 4.—A man, aged sixty years, with a smoker's cancer of about four years' duration. The growth began on the left side of the lower lip. Two years ago glandular involvement appeared under the right submaxilla. This patient's condition when he presented himself for treatment may be seen at a glance by referring to the accompanying photograph, marked Case 4, and the effect of the X-ray treatment on the case is also to be seen. All the mouth, except a small portion of the upper lip, right side, has been eaten away; there was almost universal involvement of the lymphatic glands of the neck, the inferior maxillary bone has been eaten in two at the chin, so that the two sides move independently. The glands of the throat were so indurated and enlarged as to threaten suffocation by pressure. The whole face was swollen; and hypertrophic granulations filled the wound and everted its edges. The treatment has entirely disposed of the hypertrophic granulations, removed the swelling from the face, relieved the dyspnoea, inverted the everted edges of the wound, has relieved the pain, and allowed the general condition to improve very much. Time only will tell whether the case will be cured, a result that I hardly yet dare to expect. However, if nothing more is accomplished than what is here demonstrated, the treatment cannot be said to be a failure. The case is still under treatment.

"Case 5.—A man, aged thirty-nine years, noticed a hard scale on his cheek six months ago, which he picked off. The scale soon reformed and grew so as to form a red papule with signs of breaking down in the centre. There may be a question as to the diagnosis of this case, but it seemed sufficiently clear to me to include in this report. Three treatments a week for six weeks resulted in the entire disappearance of the growth, and now, four months later, there is still no appearance of its return.

"Case 6.—A woman, aged thirty-two. Three and one-half years ago the crown of the wisdom tooth on the right side of the lower maxilla broke off, leaving a ragged edge. This tooth irritated the side and base of the tongue, finally resulting in an ulcer which has resisted every effort to heal, and has been repeatedly diagnosed as cancer of the tongue. There was a small glandular enlargement in the neck near the base of the tongue. One and one-half years ago

the sore was thoroughly curetted, with temporary benefit. Afterward plasters were used. There was considerable pain. Twelve weeks' treatment gave considerable relief from the pain and reduced the size of the sore somewhat; but the patient became restless and quit the treatment.

"Case 7.—A man, aged fifty-seven years, having a smoker's cancer of two years' duration, which had eaten away the entire lower lip and encroached rather close to the chin, with a secondary growth under the chin. This case showed evident signs of healing at first, but of late there is a tendency for the ulcerative process to extend along the inside of the cheek. All we have gained in this case is relief from pain and suppression of all tendency to form hypertrophic granulations. This case is still under treatment.

"Case 8.—A man, aged forty-four years, whose photograph accompanies this report, being marked Case 8, presented a large ulcerating growth on the left side of the face, three inches in diameter, also a large secondary glandular enlargement below the ear and a small one under the chin. The eye was much inflamed, and a small nodule with an ulcerating apex involved the lower eyelid. This cancer resulted from the kick of a horse four years ago; but its growth has been almost entirely during the last two years. A year ago an extensive operation was done in an effort to eradicate the disease, and this was followed by several secondary operations with the same object in view. All failed, however, and plasters were resorted to without success. When this patient presented himself he could not stand or walk alone, but was assisted by two people. His pulse averaged 130 beats per minute. He was extremely emaciated and suffered tortures from the painfulness of the disease, relying upon antikamnia and codein in large doses for relief. In spite of extreme cleanliness the sore was very offensive and was discharging freely. Now, after five-months' treatment, this man walks many blocks a day without assistance, requires no opiate, is free from offensive odor, and the sore has healed to a marked degree, as shown in the accompanying photograph.

"Case 9.—A man, aged sixty-four years, had an epithelioma on the ala nasi of four years' standing. The growth measured one inch in length and one-third of an inch in width, and was separated from the inside of the nostril by tissue hardly thicker than tissue-paper. Two-months' treatment healed the sore, which I am sure remains healed, or the patient would have been back again.

"Case 10.—A man, aged about fifty years, had several scabbed spots on his face, with the history of removal of the first one that appeared with the knife. This soon recurred, with others, and on second removal the specimen was examined with the microscope and pronounced epithelioma. I gave two ten-minute treatments to two of these spots, with an interval of a day, and let him go South to his business with directions to return in a month. He did not return till four months had passed, however, when I found the two spots



treated were clean and healthy. I then treated the remaining spots in a similar manner, and have not heard from him since.

"Case 11.—A man, aged fifty-nine years, had an epithelioma of the lip which started about two years ago. It never amounted to much till a year ago, when he consulted a physician, who said it was cancer, and should be removed. He accordingly submitted to an operation. About a month later it reappeared, and he had it immediately removed, only to have it recur in about two weeks. He had it removed the third time, and it recurred in less than a week; so he refused to have any further operative work, but went to a cancer hospital, where chloride of zinc plasters were used. After some five-months' treatment in that institution the growth had progressed rapidly, so as to involve the right side of the lower jaw as far back as the angle, the inner side of the cheek, the cervical glands of the neck very extensively and almost as low as the clavicle, underneath the chin, and there was some glandular involvement on the other side. When presented to me he had been living some months on liquid food, and the septic condition of the cervical glands was so bad as to cause a daily rise of temperature to  $101^{\circ}$ . There was constant oozing of large quantities of pus from many sinuses; there was a large hole in the right cheek with everted edges, from which protruded a fungus mass of unhealthy granulation-tissue. The pulse in this case averaged about 110 per minute. Three-months' treatment resulted in the disappearance of the fungus granulations, reduction of the swelling of the face, relief of the pain, and some temporary increase of strength. The treatment seemed only to increase the formation of pus in the tissue, however, which interfered materially with the progress of the case. This patient finally succumbed to the prolonged suppuration.

"Case 12.—A man, aged thirty-nine, had his left testicle injured four years ago. The organ had pained him at times ever since. About a year ago he noticed it was growing larger quite rapidly. Last March the organ was removed and examined microscopically and pronounced to be a carcinoma. Four months later the patient had a recurrence of the pain, and examination revealed a nodule in the inguinal canal on the cord. This nodule seemed to be attached to the surrounding tissue, and was declared by the surgeon who had operated in the first place, and by two others in consultation, to be a recurrence of the cancer. The patient, being discouraged by the failure of the first operation, refused to have a second, and decided to try the X-ray. After six-weeks' treatments of three per week for six minutes, each at five inches distance, the nodule has entirely disappeared, as has also the pain. The surgeon above referred to examined the case after the treatments and concurred in the opinion just stated.

"Case 13.—A woman, aged sixty-five years, was annoyed by a small scale which appeared on her cheek in front of the left ear. This scale itched and burned so she scratched it off. It immediately

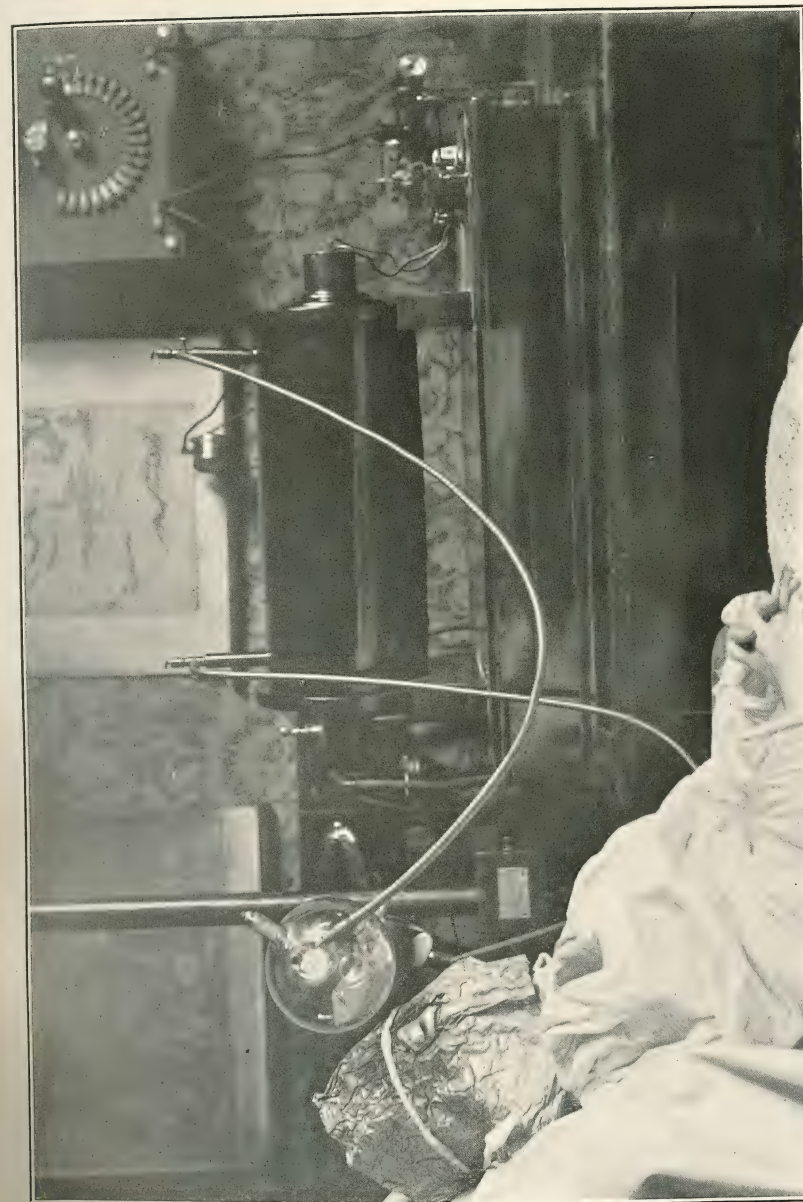


PLATE 174.—Instruction Plate showing "How not to do it." For a small lesion of the lid do not cut hole in mask larger than the whole eye. Do not lay the metal directly on the skin. Photographed for this work by Dr. G. Stopford Taylor, Liverpool, Eng.



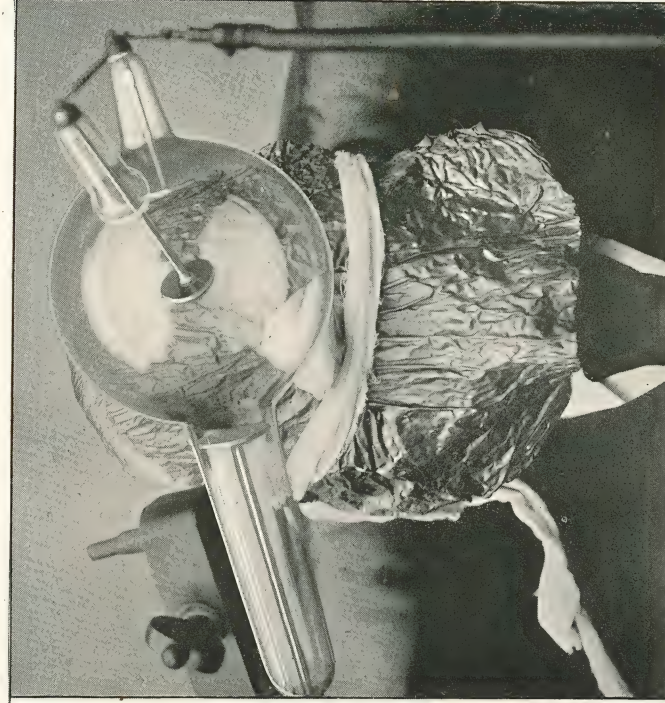
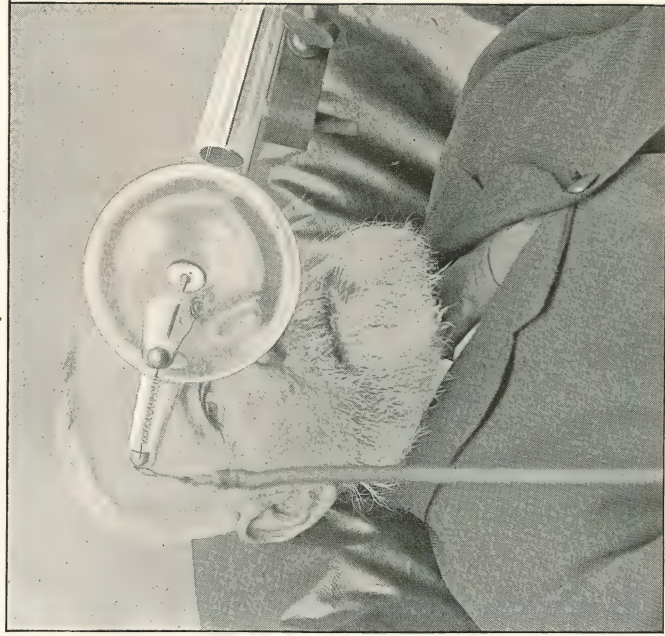


PLATE 175.—Epithelioma of Nose. This pair of Instruction Plates shows the face without shield to teach the relation of tube, and the patient completely prepared for lighting up the tube. The surface of lesion has been scraped to facilitate action of rays. Position of tube focussed on lesion with glass wall a hand-breadth distant is well shown. Then a layer of surgical cotton is placed over the part, and the shield tied on. Exposure is then made as taught in the text. Photographed for this work by Dr. G. Stopford Taylor, of Liverpool, Eng.

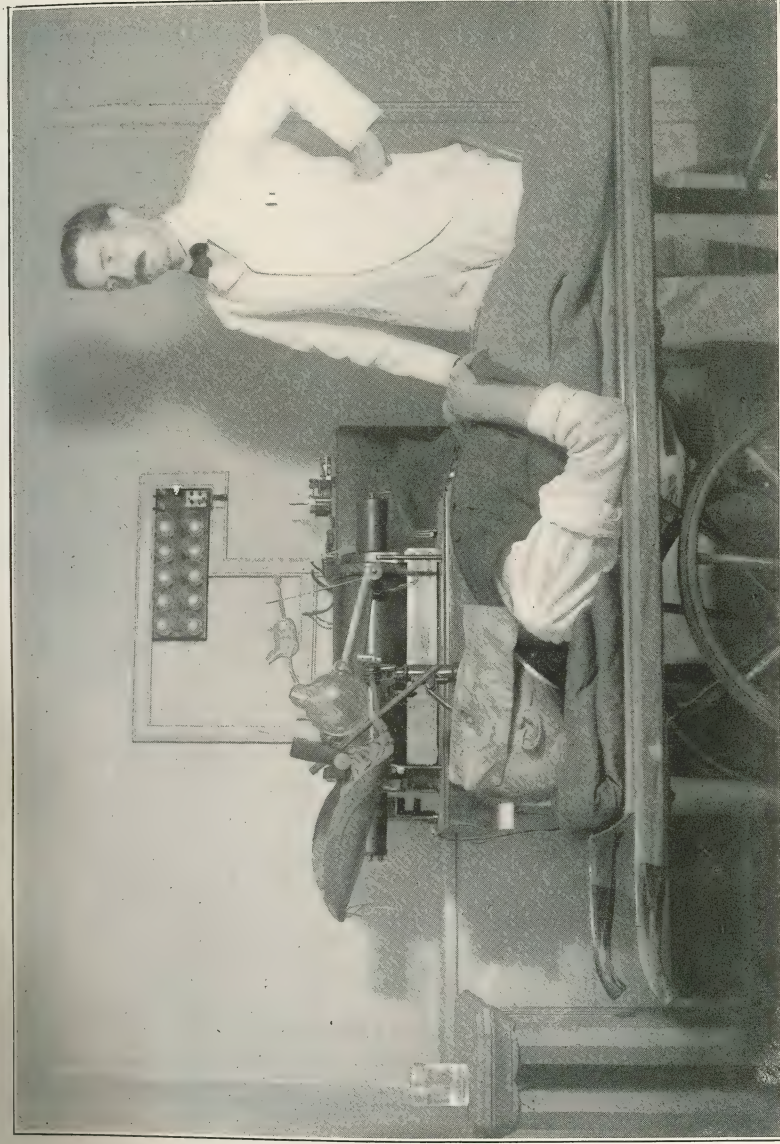


PLATE 176.—This Instruction Plate shows the technic employed in the X-ray treatment of the two cases of cancer pictured in the next plate, and reported by Dr. Pfahler. See text for description.



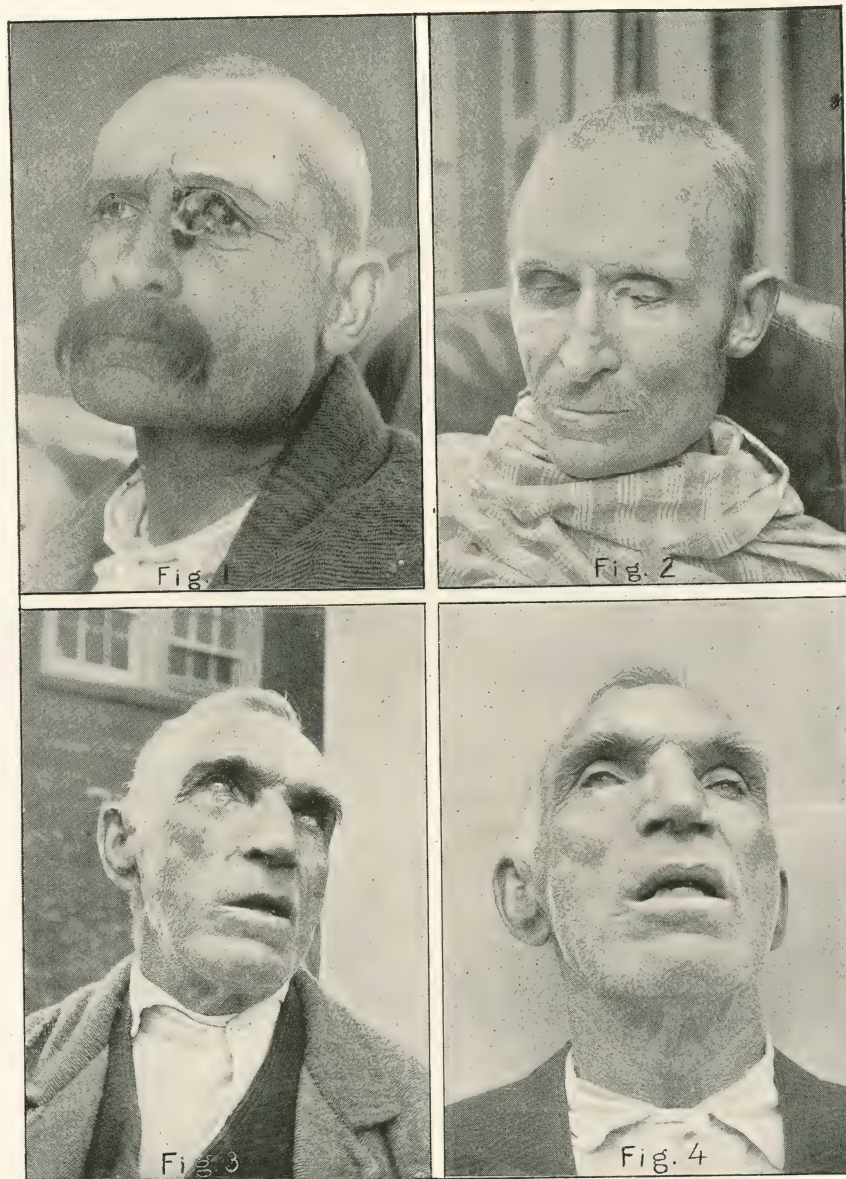


PLATE 177.—Photograph No. 1 shows the extent of the lesion in Dr. Pfahler's second case at the time X-ray treatment was begun. No. 2 shows the reduction of the lesion obtained in thirty-four exposures before the patient died from complications. Photograph No. 3 shows lesion on right lower eyelid of Dr. Pfahler's third case of epithelioma before treatment was begun. Fig. No. 4 shows the result of treatment.

returned, to be scratched off again. After repeated removal and recurrence it developed into a small nodule the size of a dime, with a disposition to ulcerate in the centre; and the itching now amounted to pain. There was a small glandular enlargement below and in front of the ear. About a dozen treatments, given three per week, resulted in the entire disappearance of the nodule without scarring the surface, and there is no sign of return, though four months have passed since treatments were stopped.

"I pass to the following deductions from the cases reported, viz.: that the application of the X-ray is capable (1) of healing epithelioma of the face without deep glandular involvement; (2) in some cases at least, of relieving the pains of cancer; (3) of destroying the exuberant granulations of cancers which are the source of much offensive discharge as well as increased disfigurement; (4) of removing incipient epithelioma without production of scar; and (5) of accomplishing all these things without pain."

Johnson and Merrill reported as follows:

"We are firmly convinced that, by means of the proper application of this agent under conditions of no practical discomfort to the patient, we can bring about the painless removal of slow-growing epitheliomas. These growths, especially when they occur on the face, are very disfiguring; if allowed to progress they produce a condition loathsome in the extreme. Treatment of such cases by the X-rays leaves a remaining defect that is incomparably better in cosmetic results than that which must accompany extirpation by knife or caustic. Furthermore, our experiments lead us to believe that even in inoperable cases of carcinoma attacking superficial parts, we may give great relief from pain and can even slightly prolong life. If we can dispense with the use of opiates in this class of cases and free the patients from pain while leaving the intellect clear and digestion undisturbed, we have made a great improvement in the therapeutics of this condition.

"To substantiate our statements we offer the following reports of cases already treated.

"Case 1.—Mr. G., aged forty-five. His father died of cancer of the lower jaw. Eight or ten years ago he noticed on his left cheek a small pimple. In 1894 the diseased area was removed and the actual cautery applied. A year later the ulcer had returned, larger than before; a second operation was performed with apparent success, but in three years the disease had returned in full force and a second centre had developed on the right side of the nose. The several surgeons who had had charge of the case pronounced it epithelioma.

"The applications with the X-ray commenced September 6, 1899, and continued until October 9th. The exposures were made every other day until fifteen were given, ten to the nose and five to the cheek. A marked reduction in the quantity of the discharge was the



first result noted. This appeared in about three days. Then the scab of dried secretion which formed over these surfaces would form more slowly and remain adherent longer each time.

"The last exposure, made with an extremely active tube, set up a severe dermatitis, though the application lasted only five minutes. The surfaces became inflamed, the discharge profuse and watery; a typical X-ray burn was produced. Treatment was suspended for six weeks. At the end of that time a healthy cicatrix had formed over both areas. When last seen, six months after the last exposure, smooth white scars slightly depressed, invisible at a distance from the patient, had replaced the original ulcers.

"Case 2.—Mr. I., aged forty-eight, applied for treatment February 17, 1900. Five years earlier the tip of his nose was accidentally scratched and, while the place was still raw, it was bitten by a fly. The part immediately became very painful and began to swell. Thinking that he had been poisoned, he consulted a physician at once, with the result that vigorous treatment with chemical caustic continued from that time until the above date. His physicians diagnosed the disease as lupus vulgaris.

"A small piece of the edge of the ulcer of the right side was removed for a microscopic examination; the result proved the disease to be an epithelial cancer and not lupus.

"We began treatment at once, exposing the right side of the nose on every alternate day until it had had three exposures of an average length of six minutes each. One week later the left side was given two treatments. An interruption of three weeks followed, during which time a mild inflammation set up in and about the cancerous tissue. On March 31st the second photograph here reproduced was taken. As the left side had not completely healed over it was given three more exposures. On April 14th, the entire external surface was covered with healthy skin. A small diseased centre still remained, however, about the perforation in the septum. Treatment at this place commenced May 12th. The area is now progressing rapidly toward healthy tissue, though sufficient time has not yet elapsed to effect a complete cure.

"The accompanying photographs, taken February 17th and March 31st, indicate better than any description the original condition and the improvement.

"Case 3.—B. C., aged sixty. Some time in the latter part of the summer of 1899, he noticed a small abrasion about the middle of the lower lip at the junction of the skin and mucous membrane. This became painful and spread steadily until the patient applied for treatment February 21, 1900.

"The original condition was as follows: 'At the middle of edge of the lower lip is a small tumor, almost spherical in shape, 2.5 centimetres in diameter, extending about equally over the mucous and skin surfaces. Where the surface is not covered with a crust, it dis-

charges a bloody, foul-smelling serum. The patient complains of constant pain in the diseased part.'

"A small piece removed for microscopic examination proved it to be epithelioma, as is shown by the accompanying photomicrographs.

"Treatment was instituted at once. The growth was exposed to the action of the focus tube on every second day for four exposures. There followed an intermission of eighteen days to determine the severity of the dermatitis produced. March 20th treatment was renewed and three additional exposures were given.

"The results noted are, first, a disappearance of pain in the lip which followed the first treatment and remained permanent; second, the quantity of the discharge was lessened and the discharge itself lost its offensive character; third, very little dermatitis was produced and the tumor did not diminish in size. The patient did not return for treatment after March 23d. Improvement in this case consisted in the relief from pain and from the offensive discharge.

"Case 4.—Mrs. S., aged thirty-three. After her third child had been weaned she noticed a tumor in the right breast which rapidly increased in size. Her physician advised removal and excised the entire breast in the early part of the year 1899. A few months later the tumor returned and a second operation was necessary. This also was unsuccessful. Removal by paste was then undertaken, and these applications continued until the patient came to us in April, 1900.

"The following observations were then made: 'The patient is weak and anæmic, has no appetite, and complains of much pain in and about the scar of the first operation. This extends from the axilla to the sternum, which, with the surrounding skin, is bound tightly down to the ribs beneath. Above this scar at the axillary end there is a small nodule which may be due either to a diseased gland or to the puckering of the tissue in the contraction to form the scar. This had escaped the patient's notice and was not observed until we called her attention to it. A little internal to the mammary line above the scar is a tumor, about five centimetres in diameter. This mass, like the scar-tissue, is tightly bound to the ribs, and while not painful to the touch is a centre from which at intervals shooting pains radiate. This tumor has sharp, well-defined margins. Below the scar, on the sternum, is an open ulcer from which a tumor is said to have been removed by paste only a week previous. This application had been made three times here without effecting a cure. There is, however, a scar slightly external to this place, from which a tumor is said to have been successfully removed by this process.

"Treatment began over this open place first, then over the large subcutaneous tumor, and, lastly, over the nodule at the anterior border of the axilla. The time during which the patient has been under treatment extended from April 9th to the time of writing, May 21st.

"During this interval the patient has experienced absolute re-



lief from pain, has increased in weight and has improved in general appearance. The open discharging ulcer has been changed to a cicatrix, over the centre of which a dry scab one centimetre in diameter has remained for twelve days. The original opening was four centimetres in diameter. The margin of the large tumor has softened, and its diameter has reduced one centimetre. The tumor also seems to be less prominent. No change has yet been observed in the nodule owing to the shortness of the time it has been under treatment. The entire relief from pain and the generally improved condition of the patient would seem to justify the treatment, though the report at this time is necessarily incomplete. Treatment will continue for the present.

"Case 5.—Mr. P. C., aged seventy-two years. He says his present trouble dates from a razor cut, of the external nasal septum, inflicted several years ago. This would not heal, for he kept continually scratching and rubbing it, on account of its intense itching. His nose before the onset of the disease was thin, sharp, and straight, but it has gradually taken on the bulbous, knot-like appearance, shown in the accompanying photograph. The external surface of nose appears slightly reddened and presents five ulcerating surfaces, which are only slightly depressed. They discharge a considerable quantity of purulent serum, having a disagreeable odor. A section taken from the nose for microscopic examination proved it to be a typical epithelioma. Patient complains of great itching in nose.

"Treatment began at once, July 1, 1900, with an exposure of the whole end of the nose for seven minutes to the most intense burning ray we could produce. Although a decided dermatitis appeared by the end of the week, treatments of twenty minutes each were given on July 7th, 9th, 12th, and 16th. The whole surface exposed soon developed into one large discharging ulcer which did not commence to granulate over for three weeks. By the end of August the nose had become entirely covered over by new skin and very much diminished in size. The second photograph was taken November 2d, just four months after Fig. 6, and shows an apparently complete return to the normal.

"Case 6.—Mr. M., aged fifty-five, presented himself for treatment August 3, 1900. He had a small superficial ulcer four to five millimetres in diameter on the tip of his nose. This presented a slightly depressed, easily bleeding surface from which exuded a small amount of serum. He said that for two years this had been treated by dermatologists and others without any beneficial result. In fact the place became progressively larger and worse. It never discharged more than enough to keep it covered with scales, or later a scab. A portion for microscopic examination was not obtainable, but the symptoms, history, and appearance all warrant the diagnosis of epithelioma.

"Treatment was commenced August 3d, with an exposure of seven minutes. This was followed by seven-minute exposures on

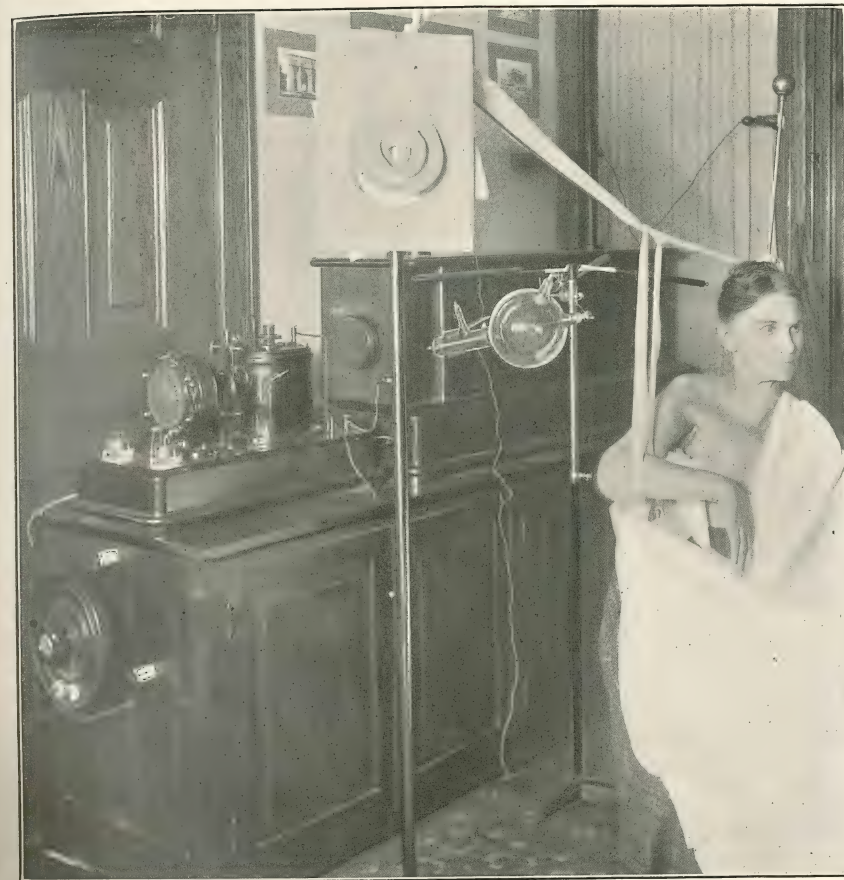


PLATE 178.—Case treated by Dr. F. H. Blackmarr, Chicago. "Mrs. G., age fifty-two, scirrhus cancer of the right breast. Photograph shows the hopeless aspect of case. Under treatment for one month; X-ray exposures; only soft tube used; severe burn resulted. Hardened area disappearing; lymphatics still involved. Marked improvement as far as pain, discharge, and odor is concerned. Photograph shows method of support of arm for treatment of glands in the axillary region. Mask hanging upon standard at the left of patient and above coil, is my form of lead mask for small areas of exposures, closing all the openings except the small one, and as I desire to enlarge opening for larger areas, I simply turn the disks of lead from the centre upward. Treatment of this case averaged twenty minutes daily for one week, fifteen minutes daily for the second week, and ten minutes for the third week, gradually shortening the time of exposure until 'burn' develops, or marked improvement has become evident. The position of the tube is not shown in the photograph, but should be placed within six inches of the breast."



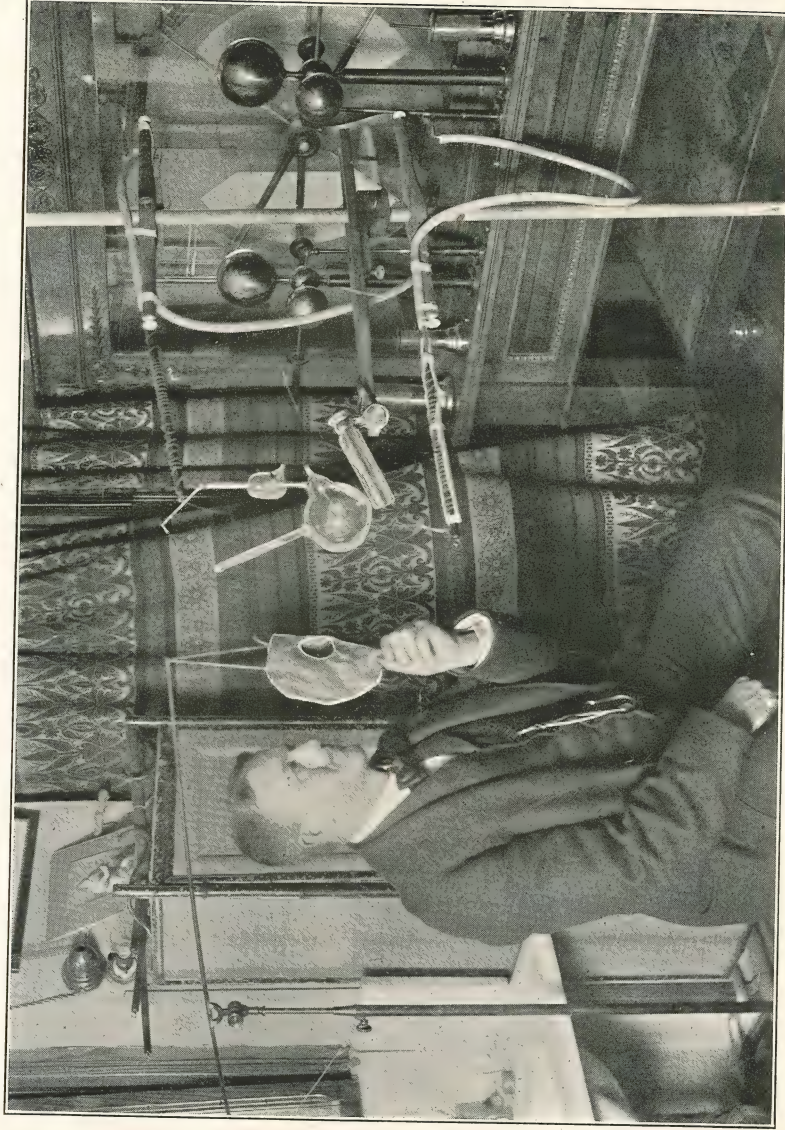


PLATE 179.—"Mr. H. E. S. Case referred to me two years and two months ago. Epithelial cancer of the face and nose; destruction of right side of nose and upper lip, involving a very small area of the floor of the orbit. Still seems to be cured." (Blackmarr.)

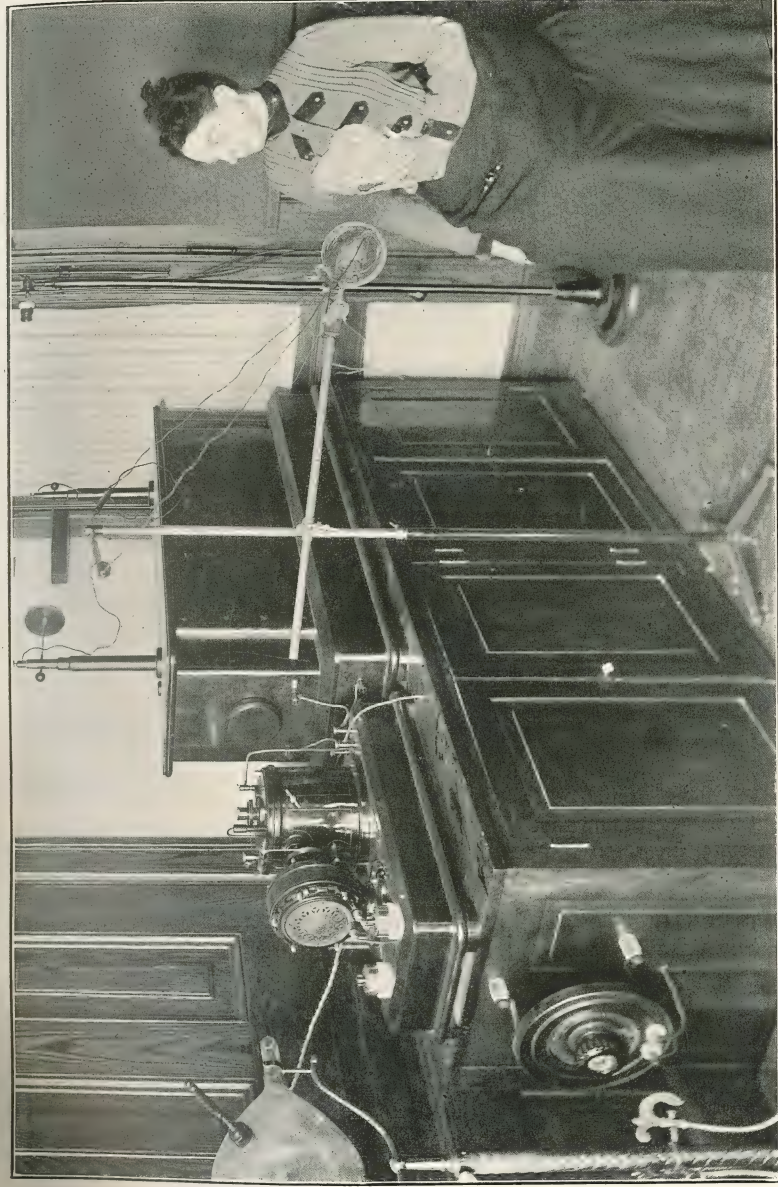


PLATE 180.—"Scirrhus Cancer of the Breast. Had been operated on unsuccessfully. Began X-ray treatment July 27, 1901. Improved from the start. Last treatment recorded September 13th. The hardened areas disappeared, but the lymphatic glands were not improved perceptibly." (Blackmarr.)



each of the following dates, August 8th, 11th, and 13th. The part of the nose treated reacted promptly, but the inflammation produced was not severe enough to cause profuse discharge or slough. The surface promptly healed over, and two weeks later no remnant of the disease was apparent. There has been no sign of recurrence up to the present time, November 23, 1900.

"At the time of exposure the patient experiences no uncomfortable sense of heat. In fact, there is no sensation whatever. The time required for the treatment is not burdensome in view of the palliative results which occur almost immediately and the permanent benefit obtained in a few weeks. The photographs of case two were taken only six weeks apart. The relief from pain followed the first treatment in three cases. This is surprising when one considers the persistent character of the pain in these cancerous growths. Cases one and three show far better cosmetic results than could have followed radical surgical interference."

We are able to supplement this report by a personal letter from Dr. Johnson, written July 24, 1901, kindly giving the author the following information: "We have since treated several additional cases, with results that are encouraging to us. Of the six cases reported in December, 1900, Nos. 3 and 4 have since died; Nos. 1 and 2 are still under occasional treatment for outbreaks in new localities near the original ulcers. Nos. 5 and 6 are still completely well, with no sign of recurrence."

Six cases of cancer have been treated by Dr. G. E. Pfahler, Assistant Chief Resident Physician and Skiagrapher to the Philadelphia Hospital, who reports three of them as follows: \*

"Case 1.—A white woman, aged seventy, admitted to the hospital July 5, 1900, for senile dementia. Family history negative. Twelve years ago a small sore developed on the bridge of the nose under the bridge of her spectacles. A crust soon covered the sore. Each time it was removed and reformed the ulcer was a little larger. This increase in size became more rapid during the last year. It was especially noticeable after her admission to the hospital. Her mental condition improved, and she was transferred to the skin ward. The growth on the nose was diagnosed as cancer by the visiting surgeons and dermatologists, and was considered inoperable. After consultation with the dermatologist on duty we decided to expose the growth to X-rays. At this time the cancer involved the entire base of the nose, was 3.5 centimetres in diameter and extended into the inner canthus of both eyes.

"Treatment was begun February 12, 1901. All of the face but the cancer was covered with a lead-mask. Ten-minute exposures

\* From "Treatment of Cutaneous Cancer by the X-Rays," read at the second annual meeting of the American Roentgen-Ray Society, Buffalo, September 11, 1901.



were made every second day with the part ten inches from the tube. The current to the primary of the coil was ten amperes. The tube was a self-regulating type. It was adjusted for a 'soft light' to a vacuum corresponding to a parallel spark-gap of from four to six centimetres. The first effect was a drying of the secretions, noticeable after two days. Then a crust formed and the edge assumed a healing appearance. After two weeks the ulcer began to heal from the edges and was one centimetre less in diameter. In three months the ulcer was reduced to five centimetres in diameter and was replaced by healthy scar-tissue except at the inner canthus. In this region it was much improved, but not yet healed. I regret that a photograph was not made at this time. The patient then had an outbreak of insanity and treatment had to stop. Her general health also failed. We were again able to resume treatment in the early part of August, 1901. The exposures were now made longer and at a shorter space from the tube. A dermatitis resulted, producing a superficial ulceration which is now healing rapidly.

"Case 2.—W. S. Male, aged fifty-seven, brought to the hospital October 29, 1900, with general paresis. One sister died of carcinoma and another of phthisis. Four years ago a small warty growth developed at the inner canthus of the left eye. This increased in size and soon ulcerated. A diagnosis of epithelioma was made and X-ray treatment begun March 8, 1901. At this time, as the photograph shows, the cancer involved the inner canthus of the left eye, and both lids to the extent of two-thirds of the palpebral tissue, and downward half the length of the nose. One of the left submaxillary glands was enlarged. The same technic was used as in the former case. After the first two exposures a lessening of secretion was noted, and after one month of treatment the lower portion of the growth had been replaced by apparently healthy skin. There was a gradual improvement despite the fact that the patient's general condition was growing progressively worse. On account of the difficulty in handling him the intervals between treatment had to be increased, but by July 17th the open surface was reduced to five centimetres, and this was granulating. The epithelioma had been replaced with what appeared to be healthy skin (except the margin of the open surface, which was thickened), and the indurated sub-maxillary gland had disappeared. I expected him to be well of the cancer in a week or two more, when, on July 17, 1901, he died of one of the episodes of his general paresis. The accompanying photograph shows his condition at that time. I wish to add that in this case it was impossible to shield the eye completely by the lead mask, but no bad results followed, not even a conjunctivitis. He had in all thirty-four exposures.

"Case 3.—D. H., male, aged seventy. One sister died of a growth about the knee which had existed five years; otherwise family history was negative. Four years ago a small papule developed on his lower right eyelid. This never disappeared, but as fast as a crust formed it would be torn off, leaving the growth each

time a little larger than before. During the past year it has increased more rapidly in size. A diagnosis of epithelioma was made by three, the visiting dermatologist, a surgeon, and an ophthalmologist, and X-ray treatment was begun on April 26, 1901. At this time an elevated ulcerating growth occupied one-half of the central portion of the lower eyelid. (See Plates 176 and 177.)

"The technic of treatment was the same as before, except as to frequency. This was governed by the effects produced, and varied from one to nine days. In each instance the inflammatory reaction was allowed to disappear before repeating the exposure. The ulcer was completely healed by nineteen exposures covering two months. It has remained healthy during the two and a half months since treatment ceased. The ulcer has been replaced by healthy skin and a scar not more than one millimetre wide, which is freely movable. I use the word 'scar' here for want of a better term. It lacks, however, the characteristics of true scar-tissue, and is only a smooth white area in the skin. This covers a furrow which indicates the site of the previous destruction of the deeper tissues. The result obtained in this case is shown by the photograph taken two months after beginning the X-ray treatment. I have treated three other cases, all of which show improvement but are not yet well at this writing."

Dr. Hopkins recently reports:

"A change in the energizing force from the alternating current to the Static machine worked by an electric motor has certainly increased the effect of the ray on the diseased tissue. The time of exposure is a very important consideration in the treatment of this disease. At Hamburg, through the courtesy of Dr. Albers-Schönburg, I saw some skin cases under treatment. The time of exposure varied from ten to fifteen minutes; this is the general practice in Germany in treating skin diseases, particularly psoriasis, eczema, and lupus. I have reduced my exposures from thirty down to fifteen and five minutes, more often the latter period. My assistant and the parts of the patient which were not to be treated, I have found were well protected by several layers of lead-foil, glued to pasteboard or more flexible material, making an opening in this screen where the rays are desired to act. I have yet to see in my own hands, or those of my assistants, a case where any of the healthy tissues have been injured by treatment with an X-ray tube.

"The distance of the diseased portion of the body from the tube is also an important consideration. In my exposures I vary the distance from twelve to thirty inches; this is altogether governed by the effect desired, and is difficult to lay down by rule. Where daily exposures are to be made, the tube should be at a greater distance from the patient, than where exposures are to be made at longer intervals. The errors to be avoided are too long exposures, too short a distance between the tube and the patient, and improper apparatus."

"When this method by the X-ray is accepted as a general and



safe treatment by the profession at large, fewer women will conceal the existence of a growth in the mammary gland than is now the case, as there is such an inborn dread in all of us of the use of the knife. The laity should be made to understand that there is another method of procedure in the treatment of malignant disease than by the use of the much-dreaded knife. I am personally as fond of the use of the knife as any surgeon, where it is best for the patient, so I can lay down the above rule with more propriety than men who are opposed to, or, not skilled in, surgery. The following case illustrates the benefit of the X-ray treatment in cases where there is no breaking down of tissue, and the mammary gland alone is involved, the axillary glands presenting no evidence of infection.

"No. 8.—Mrs. Aurille M., aged sixty-eight years, married, has had no children, always healthy. Her grandfather died of cancer. Several months ago slight pains called attention to her right breast, which on examination proved to be somewhat enlarged. It continued to increase in size until it was twice as large as the left. She consulted me on January 22, 1901, as she heard I was using 'electricity' in the treatment of cancer, and wanted my opinion. I was frank with her, and told her that the knife was the proven treatment, but that I was experimenting with the X-ray in such cases. She said she had come to me because she was not willing to subject herself to the knife, and wanted to try treatment by the ray even though it was in an experimental stage. The next day she took her first treatment. This was January 23d, and the exposure was five minutes; 24th, eight minutes; 25th, seven minutes; 26th, ten minutes; 28th, eight minutes; 29th, eight minutes; 30th, eight minutes; 31st, eight minutes. We could detect a change in the density and size of the gland by this time, and the breast felt more comfortable. February 1st, exposure eight minutes; 2d, fifteen minutes; 4th, ten minutes; 5th, eight minutes; 6th, seven minutes; 7th, seven minutes; 8th, seven minutes. She was improving so rapidly, and the breast was so much reduced in size that I suggested an intermission of treatment for a week or ten days. February 16th she presented herself again and the condition of the tumor continued satisfactory. Treatment was twelve minutes; 18th, twelve minutes; 19th, twelve minutes; 21st, ten minutes; 22d, ten minutes, and as she was going away for ten days on the 23d I exposed for eighteen minutes. March 2d, twelve minutes; 13th, eighteen minutes; 28th, not having had treatment for two weeks I gave a twenty-minute exposure. All the time the tumor had continued to decrease, and was nearly as small as the normal breast. As she was going to her country home for the summer on May 1st, I deemed it wise to give her a few more treatments and try to bring the right breast absolutely down to the size of the left. With this end in view I gave her the following treatments: March 30th, eight minutes; April 1st, ten minutes; 5th, ten minutes; 8th, ten minutes; 10th, eight minutes; 12th, eight minutes; 16th, eight minutes; 18th, eight minutes. As the breast

was practically reduced to the size of the healthy one and all disagreeable sensations had ceased, I saw no further occasion for treatment, but cautioned her to report to me on the least increase of size, or return of pain in the breast. This she said she would do.

"In all these cases the first effect observed is a decrease in the density of the tumor. This change in consistency governs very largely the time of exposure, for, should we carry this process too far, necrosis of tissue would occur. This is a condition which we must studiously try to avoid. Experience has demonstrated that it is not necessary to carry the treatment to this extent even in advanced cases, as they will heal under less exposure than is necessary to produce complete destruction of the diseased area. In cases that have broken down and ulcerated, the effect of the X-ray treatment shows itself very promptly. *In these cases the exposure is not of necessity more prolonged than in milder cases, as one would naturally expect.*

"I have had a very interesting case where I have used a combination of the X-ray and Finsen light. This case was a patient who had had the left breast amputated and the entire axillary plexus of glands removed, as they were involved in the disease. The extensive wound healed promptly, but the cicatrix subsequently broke down and began to ulcerate. The necrosis was an inch deep. Yet under the combined influence of X-rays and violet and ultra-violet rays of the Finsen apparatus, the cicatrix has completely healed. A fungating cancer of the breast was recently brought to me for treatment, the hardened right breast was at least seven and one-half inches in diameter. The discharge was offensive; but after a few treatments with the X-ray the character of the discharge changed and the odor disappeared; the fungating mass has retracted; the whole breast is softening, and the patient is relieved of all the pain and discomfort she was suffering. She says, 'if the treatment does nothing more than make me as comfortable as I am now it is quite worth while.' Though final conclusions must be deferred I am sure that we can be perfectly justified in advising our patients to use this form of treatment." (September 7, 1901.)

"Mr. S.—Cancer of epithelial variety on right side of face. The cancer had eaten out the right side of the nose and had almost reached the orbit. The patient suffered severely; discharge and odor very bad; diagnosis confirmed by several consultants and a prognosis of three months limit of life was made. Treatment was begun a little over two years ago. A low tube and an improperly fitting mask caused the patient to be burned unnecessarily, but it was among my first cases. However, after the effects of the burn disappeared the face healed rapidly. Soon after the first treatment the odor, pain, and discharge were gone. The site has been perfectly healthy since treatment was stopped nearly two years ago and appears likely to remain so." (BLACKMARR, August, 1901.) See Plate 179.

Andrew Clarke has reported (*British Medical Journal*) a case



of carcinoma of the breast too far advanced for operation, in which the use of X-rays for nine weeks produced a marked improvement. Exposures were made for fifteen minutes at a time, five days each week. The ulceration and discharge greatly diminished, the axillary glands became smaller, and general improvement followed. In several papers during the early part of 1901 Williams expressed the opinion that we have in the radiation from a Crookes tube a valuable therapeutic agent in epithelioma, and that the beneficent action of the X-rays can be brought about without causing a burn. Without causing pain and without any caustic action the application of the X-rays is followed by a cessation of foul and almost unbearable odors, a lessening of the discharge, and diminution of the size of the growth. Even if its curative action is found to be limited to superficial growths, it may be of use as a means of relieving the painful features of other forms of the disease. In one special case reported, five-minute exposures were made nearly every day for some weeks. Experience has suggested that so long a period of treatment is unnecessary. The diagnosis of epidermoid cancer was confirmed by histological examination and a picture of the case showed the ulcerated and indurated margin of the lower lip, the induration extending some little distance into the tissue. A lymphatic gland under the lower jaw on the right side was enlarged. At the close of treatment the induration had disappeared; the lip where the growth had been was without a scar and perfectly smooth and soft; the enlargement of the lymphatic gland had disappeared; and, except a little increase in width on the affected side, there was nothing abnormal in its appearance. Later, this increase in width diminished so that the cosmetic effect was perfectly satisfactory.

Dr. J. H. Sequeira reports a series of twelve cases of rodent ulcer which he has treated by the X-rays. The current used was one of from three to four amperes; the coil was a ten-inch spark, and the tube was placed about six inches from the ulcer, the adjacent parts of the skin being protected by a layer of lead-foil. The treatment lasted ten minutes and was repeated daily. So far the author has only treated cases deemed to be unsuitable for operation. Of his twelve cases, eight are still under treatment and four are under observation, the ulcers having healed. In no case has there been a disappointing result, and all the cases still under treatment are in various stages of healing.

Stembeck reported, in April, 1901, a case of rodent ulcer on the tip of the nose of a woman, aged sixty-seven, treated by X-rays. They were applied for ten minutes daily, with the tube at four inches.

Reaction occurred after four sittings, and on the tenth pus appeared. After thirty-five treatments the ulcer was more healthy, and the epidermis began to grow in from the edges. After a short interval the sittings were increased to fifteen minutes, and a second reaction took place followed by improvement. The epidermis grew over the ulcer, the edges flattened down, and in a month a smooth cicatrix was left differing little from the facial epidermis, and surrounded by a slightly raised border. The ulcer had been present nine years. In other chapters of this section we have several references to the treatment of rodent ulcer, and shall make no attempt to collect additional cases here. Many of the large European hospitals which are doing active therapeutic work with X-rays report the daily treatment of a dozen or more cases of Rodent ulcer in the X-ray clinic. Results are praised very highly.

In July, 1901, the Electrical and Radiographic Department of the London Hospital was treating daily by X-rays some three or four dozen cases of skin disease, of which about half were rodent ulcer and the other half lupus. In the Finsen Light Department of the same hospital, the number of cases treated each day was about 100, chiefly lupus. The opportunities for comparison on such a scale should determine the relative merits of each method. At the date reported the discharges from X-ray tubes appeared to be more efficient than concentrated light in the treatment of rodent ulcer. At the beginning of 1902 we find a great increase in hospital work of this nature in many quarters of the globe. We still, however, await results in cases of internal cancer.

**Method of X-Ray Treatment.**—The technic in all these ulcerating lesions is practically the same as explicitly taught in our study of lupus. Vary the details of dosage according to the observed effects, but follow the same principles in all. The greatest possible benefit will be given most patients by combining the use of Static electricity with X-ray exposures. Employ this current alternately, both for local assistance and especially for its great capacity to improve the general nutrition and well-being of the patient. Correct methods of technic have been taught by the author in his writings on this form of apparatus. Those who know Static electricity only in its common routine applications will be greatly pleased to learn how to enormously increase its efficiency in these cases. Many cases of sarcoma have been tentatively treated with X-rays, and many are encouraged by the results. In all classes of cases treated by electrical radiations of any kind the best results have been gained when the lesion has presented an exposed surface. Affected glands under sound



skin have not yielded as good results. A few cases of internal cancers have been treated and much benefit has been claimed by some. At this writing we can only leave the subject to investigation and further research. See Plates 174, 175, 176, 178, 179, and 180 for pictorial methods. Also note remarks on page 73 regarding lead masks for malignant disease. Study carefully our entire section on X-ray therapy and apply the principles to any given case. Our pictures of technique, photographed especially for this work, show clearly how to proceed in a variety of cases.

## CHAPTER XLII

### TUBERCULOSIS AND X-RAY THERAPY

#### LABORATORY AND CLINICAL RESULTS. TECHNIC FOR X-RAY TREATMENT.

If the X-ray was demonstrably capable of carrying with its penetrating capacity an electro-chemical action destructive of microbes into the tissues, the treatment of consumption would be solved. Some have thought that the problem was nearly as simple as this, and have accepted as final the early conclusions of Rieder. It is the author's personal opinion that the action (if any) of X-rays upon tuberculous internal tissues ought to have been proved long ere this, but proof is still wanted. Owing to the fact that X-rays penetrate so freely the human body it would apparently be of immense therapeutic importance if it could be proved that they possessed the properties of destroying germs or retarding their growth or of so increasing tissue resistance as to aid nature in overpowering bacilli. Theoretically, it ought to be very easy to prove this one way or the other. After four years of active research and a large therapeutic experience, it ought to be settled whether or not the X-ray will carry through the tissues the one decisive action for which the profession waits.

Practically the question appears to be very difficult to settle, and is as open in 1902 as it was in 1896. When a culture in any tube is exposed by an investigator it may be exposed at a greater or less distance, for a longer or shorter time, to a discharge of a higher or lower intensity, and the media may differ; hence, discordant statements and discrepancies appear which bewilder us with the uncertainties of scientific bacteriology. Some authors kill bacilli with X-rays, some make them grow more slowly, some stimulate them to increase activity and growth, and some grow them gradually to death. When cultures are X-rayed they may be influenced by:

1. The X-rays proper.
2. The cathode rays.
3. Electrical actions.
4. Ozone generated by the electrical discharge.
5. Increase of temperature.



6. Chemical or other changes in the media.

7. Light from the tube, or other source.

These would seem to be controllable factors. Light can be excluded by inclosing the tubes in black paper the same as a photographic plate. The culture can be replaced sufficiently distant from the anode to be beyond the reach of cathode rays and the electrostatic field. Ozone can be eliminated, and it would certainly seem that long ere this the question should have been decided. We will not confuse the reader by citing at length any of the more important but conflicting contributions on this subject. However positive the evidence may be in any single report we are obliged to regret that proof of direct germicidal action is not conclusive. Much of the applause given X-rays in tuberculosis and parasitic skin diseases has been based upon the supposition that X-ray therapy was, in fact, the long-sought antiseptic therapy, and even if it is not possible to demonstrate this with culture tubes and biological incubators, it ought to be possible to do it in the simplest manner upon the living patient. If X-rays carry with them through the tissues any destructive influence on bacilli then we should be able to place a tuberculous patient in the path of the rays and in the course of time find out from the sputum whether or not there was any destruction of the bacilli. Ten competent clinicians experimenting each on ten different patients for a year should be able to settle the matter regardless of other methods. Whether or not the benefits derived from X-ray treatment in hundreds of reported cases have any relation to germ-destroying properties in the rays, it is certain that if the rays actually and readily kill tubercle bacilli *the fact ought to be susceptible of proof*. Clinical proof of the possession of this property would be one of the most gratifying contributions which the opening of the twentieth century could offer the medical profession.

Space will not permit us to repeat here the reports on both sides of the controversy respecting the ability of X-rays to destroy germs. At least six eminent authorities could be quoted on each side. The effect produced on cultures of micro-organisms and of tubercle bacilli by exposure to X-rays has received world-wide study and is of the greatest interest, but it is still a clinical problem. We cannot place too much reliance on the behavior of guinea-pigs under X-rays, nor on the results with patients who at the same time *have other approved treatment*. Yet the impression is growing that X-ray therapy has a useful field in pulmonary tuberculosis. Personally the author believes that the rays must be demonstrated to possess an actual bactericidal power before they can be accepted as superior to other



PLATE 181.—Raying a Case of Pulmonary Tuberculosis. The camera has made the tube appear too high. Level the axis of the rays directly upon the diseased area. The plate shows the operator inspecting the progress of the disease with the fluoroscope. In a systematic course of treatment expose the back of the patient at one sitting and the front at the next sitting, and alternate at successive sésances. A chair with an open back to support the patient should be used.

Photographed exclusively for this work by Dr. Jicinsky, who reports: "J. H., age twenty-six, fluoroscope shows slight haziness over both apices; anode focussed directly upon diseased area; tube twelve inches from surface of body; exposure ten minutes at first four times a week, then three times a week. Used improved German tube and ten-plate Static machine. After two months' treatment patient had gained ten pounds. Night sweats ceased; coughed no more. Regulated personal hygiene, but gave no medication. Feels improved and haziness nearly gone."



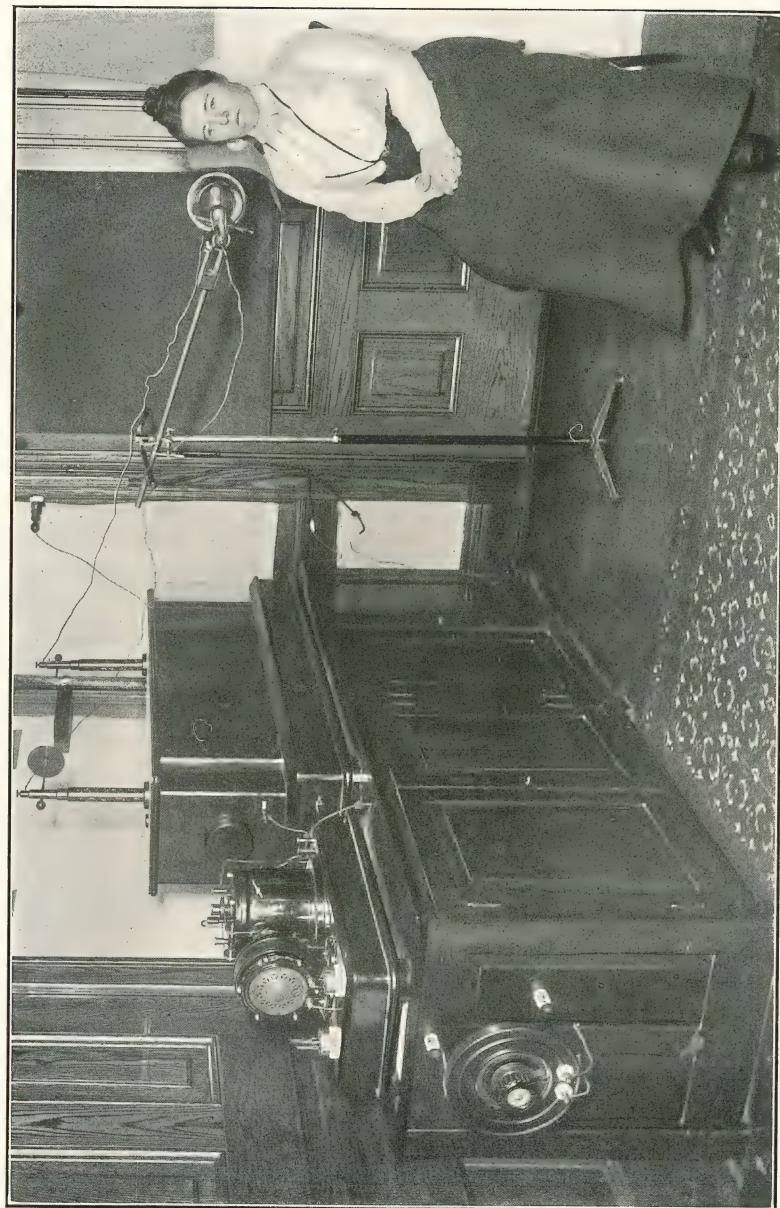


PLATE 182.—Case treated by Dr. F. H. Blackmarr, Chicago, and method photographed especially for this book. "Mrs. V., history of tuberculosis. Operation upon cervical glands. Patient well for short period after operation. Remaining glands enlarged to the size of walnuts. X-ray exposure, time varying from ten to fifteen minutes daily, until marked 'sunburn' developed. After first week no night sweats, appetite improved, patient feeling better. She has been well now for nearly eighteen months."



PLATE 183.—Rabbit being X-rayed for tuberculosis test after inoculation with bacilli. Photographed by Dr. Jicinsky.



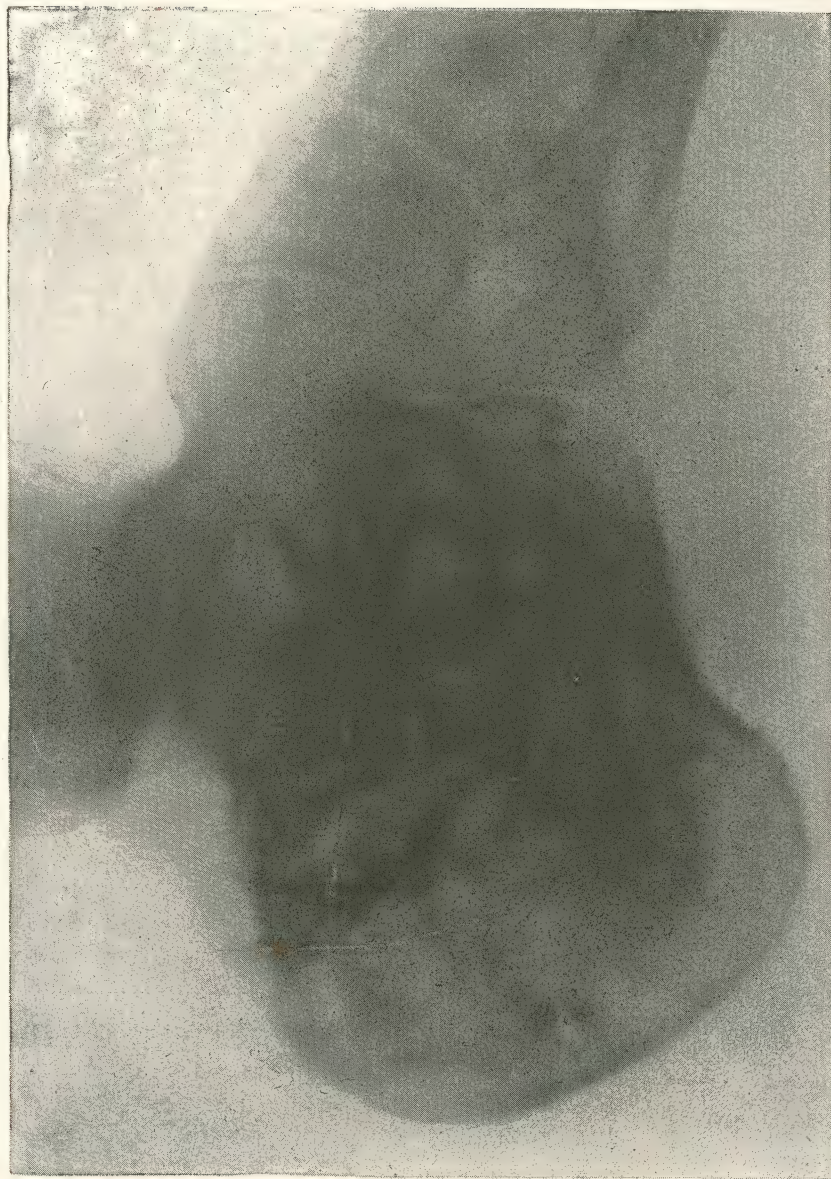


PLATE 184.—Osteo-sarcoma of the Os Calcis. (Rebman, Ltd.)

forms of efficient electricity. If the rays are merely an indirect nutritional agent without specific influence upon the bacilli the author considers that we have more flexible, various, and effective therapeutic resources in galvanic, static, and high-frequency electric currents than in the attenuated discharge which is associated with the phenomena of X-rays. But this opinion will not be maintained if evidence to the contrary is established. This chapter will now close with a recent report from a physician whose results should induce many to investigate the subject.

"My attention was first called to the possibilities of its use in tuberculosis three years ago by the relief that was found by the patient on making a radiograph of a tubercular knee-joint. I made an exposure of ten minutes with the inefficient apparatus then in use, and got a good negative, but the surgeon wished a different view and I repeated the exposure four days later. The patient claimed that he had the first relief from pain he had experienced for many months. Two weeks afterward he came back and begged for another exposure, and after a consultation it was refused. The subsequent history will be found later on. This case set me to experimenting on a few cases of tubercular joints that came to my clinic, and I found that one injection of iodoform emulsion and subsequent treatment with the ray usually was followed by immediate improvement and a subsequent recovery. It might be mentioned in passing that iodoform fluoresces beautifully under the ray. (See Plates 161, 162, and 163.)

"A bad case of pulmonary tuberculosis presented itself at this time. He had been under treatment for a number of months at the clinic, and was getting so weak that it was only with the greatest difficulty that he could get to the hospital. And he was very anxious to have a radiograph taken of his lung, and to humor him I took it; and he came back and asked me to use it again, as he had felt better than he had for some time. I had him come twice per week and take treatments, not expecting it would do him any good. No special change was noted until he had taken six treatments, when his cough left him and his temperature became normal. When he took his tenth treatment he reported that he had gained twelve pounds in weight and had been working for a week; the subsequent history will be found in the report of the case. I will report briefly a few of the cases that I have treated with the ray. They are fairly representative of the whole number of thirteen cases of pulmonary and five cases of joint tuberculosis that I have submitted to the ray treatment. It is of interest to say that they are all enjoying good health at present and pursuing their various vocations as if they had not suffered from the dread disease. As yet no relapses have been noted, but are being carefully looked for and will be promptly treated if noted. (See Plates 181 and 182.)



"Case 1.—John M., aged twenty-six, single. Met with an accident July 10, 1896, by falling off a wagon, and as he went to work the next day he apparently did not meet with an injury. August 20, 1896, he found that his knee-joint seemed to be weak and he had difficulty in using it, and it grew steadily worse until he could not bear his weight upon it. The joint became swollen and painful on pressure, and a marked atrophy was noticed of the muscles. He consulted an eminent surgeon and a diagnosis of tuberculosis was made and he was advised to have iodoform injected into the joint. He submitted to eight injections without stopping the process, and then had the leg put up in plaster for four months; and when it was removed it was so bad that an amputation or an excision was advised, and he was sent to me to determine by means of a radiograph which would be advisable.

"Two radiographs were taken of the joint four days apart, and the exposure was ten minutes each time with the apparatus then in use; and the patient claimed so much relief that he begged for further exposures, and after a consultation with the surgeon it was refused. It is interesting to know that the patient did not receive any more treatment of any kind, but recovered the use of his joint in about four months and at the same time his health and is working every day driving a team.

"Case 2.—William F., aged twenty-eight, married, pulmonary tuberculosis. Had been under treatment for four months and was steadily growing worse. Temperature 101.5, severe cough, sputa contained tubercle bacilli and streptococci; he had night sweats and a profuse diarrhoea. Treatment was given at his request and with no hope of success. Treatment was given twice a week with a very high-vacuum tube. No special improvement was noticed for four weeks, when he began to slowly improve and gain in weight, slept better, sputa lessened in amount and became more liquid and contained less bacilli, and the fever gradually left him, until at the end of ten weeks he was discharged; and, although a few bacilli are found occasionally, as far as can be told he is in good health and working every day.

"Case 3.—Margarette L., aged twenty-four, widow, one child, poorly nourished. Developed pulmonary tuberculosis five months previous to consulting me, when I was called to see her for a severe hemorrhage from the lung. Both lungs were involved and the bacilli tuberculosis were found in great quantities. She was so feeble and exhausted that it did not seem that there was even a remote possibility that she could recover. It took two weeks of careful nursing to bring back strength to allow her to ride to my office for treatments. And the first two calls were made in a cab. She subsequently came on the street cars, as she improved. After six treatments I put her on tonics, when the improvement was rapid. She increased in weight from ninety-three pounds to 118, the most she ever weighed. She has resumed her place as a waitress in a restaurant and works twelve



PLATE 185.—Multiple Osteoma. The electrotpe gives a very faint idea of the diagnostic value of the negative. (Rebman, Ltd.)



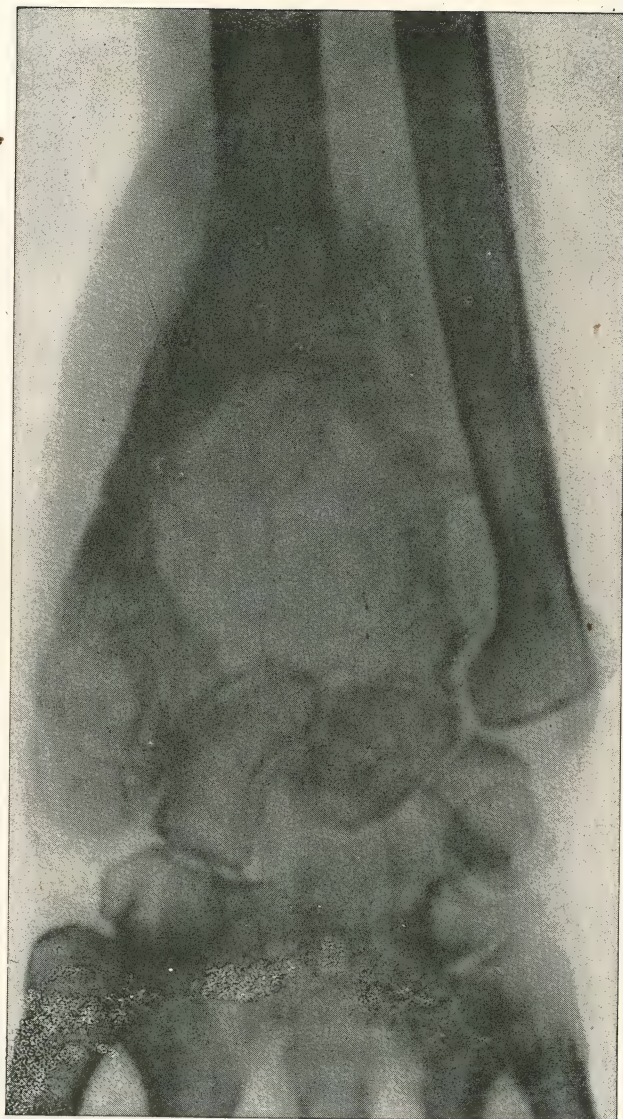


PLATE 186.—Osteo-sarcoma of the Ulna. (Rebman, Ltd.)

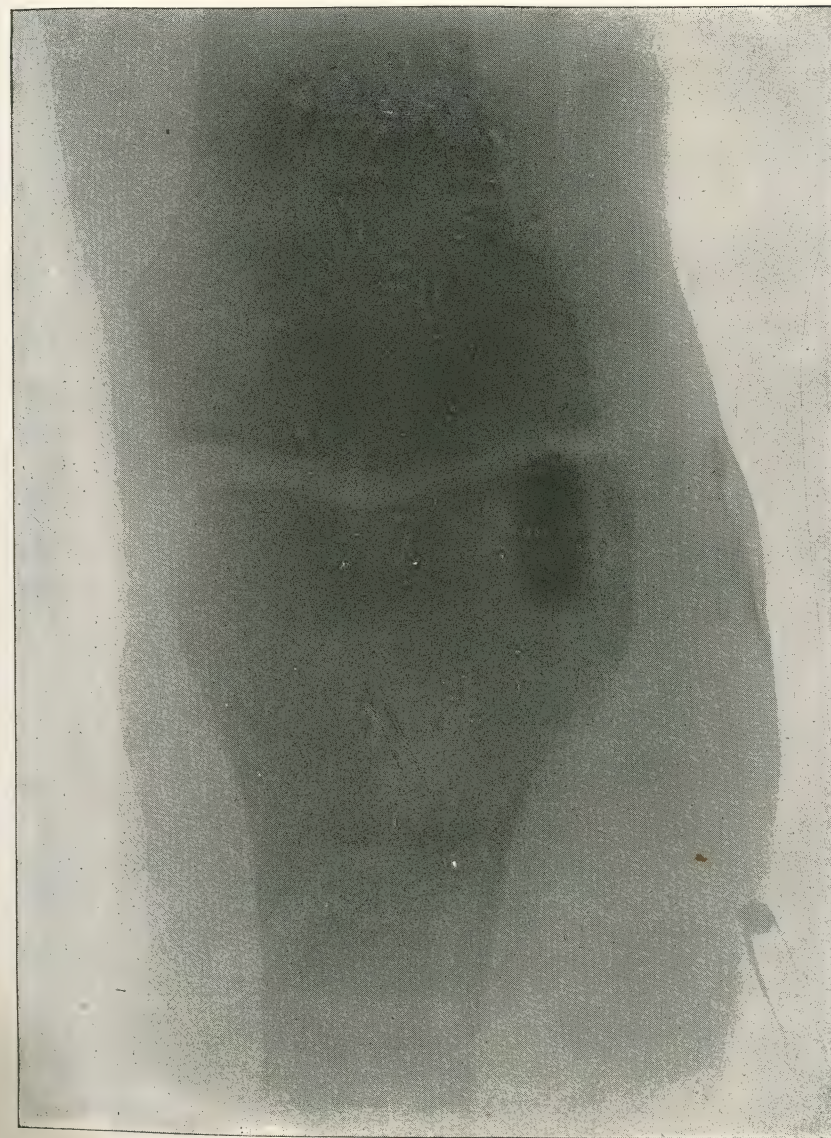


PLATE 187.—Bony Ankylosis of Knee from injury eight years previous and having been twice for long periods fixed in plaster splints. (Rebman, Ltd.)





PLATE 188.—Ankylosis of Elbow. (Rebman, Ltd.)

hours per day and has been doing it for months. I have been able to find tubercle bacilli only twice in the last year. The above cases are a fair sample of the rest that I have treated." (BURDICK, July, 1901.)

**Technic for X-Ray Treatment of Pulmonary Tuberculosis.**—Query from physician: "I have a tuberculous patient whom I wish to expose to X-ray therapy. There is some consolidation of the upper left apex and also dulness over spine in lower region. Patient has only slight temperature, slightly increased pulse, no night sweats or coughs. Appetite normal, bowels regular; in a word, incipient tuberculosis. How near ought the tube to be placed to the chest (front or rear?), what length of exposure allowed, and how often?"

Answer. Strip the thorax, either entirely or down to close-fitting underclothing. Seat the patient on a revolving stool facing a tube with its wall eight inches from the tissues, and with its focus levelled at right angles to the third rib. Use a good tube giving brilliant radiance. If you have the author's gauge to test the radiance with use at least X<sub>6</sub>. Between patient and tube fix a grounded metal screen (say, fifteen inches square), with its lower border just below the slightly raised chin to cut off action from the face, and especially from the hair. Begin the exposure with the axis of rays focussed on the apex of one side. Direct the patient to gradually turn the body so that during a séance of twenty minutes, each affected area will slowly pass into the most active path of radiation, to wit, in the central axis of the rays from the anode as taught by our Divergence Chart. A little bending and posturing of the body as it is turned from one side to the other will accomplish this. In the second treatment seat the patient with back to tube and expose the posterior tissues. Make twenty-minute exposures in this manner three times a week. While the rays penetrate through the body yet the maximum effect is nearest the tube, hence reverse the patient in alternate séances. See Plate 181.

Use all other indicated measures. Especially use Static electricity in alternation with the X-rays by methods taught in our writings on this current. From very large clinical experience and from cumulative evidence from many observers we are obliged to say that a tuberculous patient in any stage of the disease is not given the benefit of scientific therapy if static or High-Frequency electricity is omitted from the treatment. It is the most decisive and important remedy in the entire chain of our resources with which to combat this disease. The diverse indications for it call for many variations in its application, especially with reference to the digestive tract, the gen-



eral muscular state, symptomatic disturbances, the cough, expectoration, respiratory capacity, pleuritic pains, etc.

With this short chapter we shall now close our section on X-ray therapy. Resisting many temptations to insert interesting matter and to enlarge upon controverted points, we have rigidly adhered to our plan of keeping the text of this work in the strict line of practical instruction. Those who have not reviewed the diffuse and undigested literature of our subject during the past five years can scarcely appreciate the great service rendered the reader of a single compact volume by efficient and reliable condensation. This service the author has performed to the best of his ability, and it is believed that the result is a course of instruction which can be safely followed by beginners and confidently applied to their patients. After defining the essential terms in X-ray nomenclature we will next take up the related subject of photo-therapy.

## CHAPTER XLIII

### X-RAY NOMENCLATURE

#### DEFINITIONS OF COMMON TERMS EMPLOYED.

READERS of scattered X-ray literature, covering contributions by American writers and translations from the German and French, have observed a lack of uniformity in the use of X-ray terms. Some authors also attach different meanings to words already employed in a different sense by others. Some make the word "radioscopy" include the use of both the fluoroscope and photographic plates. Some use "radioscopic" in a sense that others restrict to "fluoroscopic." With one a "skiameter" is a device to place against the patient as a comparative measure of the density of shadows in fluoroscopic examinations of the thorax. With others it is a series of layers of aluminum or other metal, either punched with holes or numbered, and designed to indicate the working efficiency of a tube. Others still call a similar device a "photometer" or "radiometer."

It needs no argument to show that a standard nomenclature is wanted. And particularly a root-word is needed that will indicate by various terminations the different branches of X-ray work without confusion. Some of the new words already offered for this purpose, and deemed original by those suggesting them, appear in the dictionary with other meanings, and confusion has resulted. It is no part of our purpose to originate terms or to change the meaning of any already in use, but for the instruction of the beginner we will here note down a brief list of the more important words which have become more or less established in X-ray literature. It will be informing to first see what dictionaries already say about some of the terms employed. We find the following old definitions:

*Fluorescence*.—The property of becoming self-luminous under the direct action of light rays. This word was coined by Stokes in 1852.

*Phosphorescence*.—Shining with a faint light; luminous without sensible heat or combustion; a species of fluorescence.

*Radial*.—Of or pertaining to a ray or a radius; shooting out from



a centre; having the character or appearance of a ray or a radius. A radiating or radial part; a ray.

*Radiometer*.—1. An old instrument for measuring angles; the cross-staff. 2. An instrument which serves to transform radiant energy into mechanical work. Crookes Radiometer consists of four crossed arms of very fine glass, supported in the centre by a needle-point, and having at the extreme ends thin vertical disks or squares of pith, blackened on one side. When placed in a glass vessel nearly exhausted of air and exposed to rays of light or heat the blackened surfaces absorb the radiant energy and become heated, etc., and thus various experiments are performed which illustrate the mechanical effects of rapidly moving molecules of a gas.

*Radiograph*.—An instrument for measuring and recording the intensity of solar radiation. Improved by Winstanly in 1881. Ray-writing.

*Sciagraph*.—*Shade-writing*. The geometrical representation of a vertical section of a building, showing its interior structure or arrangement.

*Sciagraphy*.—Painting in light and shadow; the act or art of delineating shadows correctly in drawing. A geometrical profile of a section of a building to exhibit its interior structure.

*Sciagrapher*.—One skilled in sciagraphy. A student of the gradations of light and shade.

*Sciametry*.—The doctrine of eclipses and the theory of the connection of their magnitudes with the semidiameters and parallaxes to the sun and moon.

*Scioscopy*.—Same as Skiascopy.

*Ski*.—A long narrow strip of wood made into a snow-shoe.

*Skiagraphy*.—Same as sciagraphy.

*Skiascopy*.—Shadow-view. Shadow test. A method of estimating the refraction of an eye by throwing into it light from an ophthalmoscopic mirror and observing the movement which the retinal illumination makes on slightly rotating the mirror. Also called *retinoscopy*, etc.

The above are the main words defined in the Century Dictionary prior to the X-ray era. Those who cannot endure "hybrid" words such as combine the Latin with the Greek, for instance, *radiograph*—will find this word long established in *scientific* circles. But as the dictionary shows thousands of common words defined under *several* headings it need not trouble us that words adopted into X-ray usage have long had other applications. Those now permanently incorporated into this branch of practice may be explained as follows:

*Cryptoscope*.—An early term for the Fluoroscope. Now practically obsolete in this country, though still employed occasionally in Europe.

*Film*.—The sensitive surface of the photographic glass plate or the separate photographic film without the glass backing. Special films are made for X-ray work. The words "plate" and "negative" are currently used as convertible terms, but *film* specifically refers to the sensitized surface acted upon by the rays.

*Fluoroscope*.—The complete pyramidal box and fluorescing screen used for visual examinations with X-rays. Formerly called cryptoscope in its first shape.

*Fluorometer*.—A special localizing apparatus. A coined word introduced by the makers of the apparatus.

*Fluoroscopic*.—Examinations with the fluoroscope.

*Fluoroscopy*.—The science and art of using the fluoroscope in X-ray inspections.

*Radiogram*.—An X-ray picture; a term coined for this use but now nearly displaced by radiograph, which is in most common usage.

*Radiograph*.—In X-ray nomenclature the negative and the print from it are both called indifferently radiographs and skiagraphs. The intent is the same.

*Radiometer*.—Some applied this word to a measure of X-ray penetration, but it is little used, and was at once objected to because of its previous application.

*Radiology*.—Some writers have thus indicated the entire study of X-ray phenomena. It is little used in America.

*Radioscopy*.—Some have used this word to signify fluoroscopy. Others have used it to denote both "fluoroscopy" and "radiography." Foreign writers use it more than American authors.

*Radiotherapy*.—Some use this word instead of X-ray therapy. When met with in print it signifies the therapeutic application of the discharges from an X-ray tube.

*Skiagram*.—Has the same meaning as the word "Radiogram." Is very little used.

*Skiagraph*.—Same as "radiograph," and preferred by some. One is as correct as the other. Both are used interchangeably in this book.

*Skiascopic*.—Same as fluoroscopic.

*Skiascopy*.—Same as radioscopy. These words are little used.

*Skiameter*.—A device for comparing shadow-values. See description in another section of this work. A shadow-measure.

*Screen*.—Generally, the fluorescing screen used for visual X-ray



examinations. A specially prepared "screen" to place in contact with the film in making an X-ray picture is called an "intensifying," or "photographic" screen, and is fully described in another section of this work. A "protecting screen" is a thin sheet of metal used to keep electrical discharges from the patient.

These are the principal words now peculiar to X-ray nomenclature. Few and simple as they are some confusion has already occurred, especially in translations from foreign sources, from the lack of a common basis of application. Beginners, however, will soon learn to comprehend an author's meaning by the context and thus avoid doubtful interpretations. When meeting "Staniol" for the first time with reference to protecting a patient from an X-ray dermatitis know that the author who employs it simply means tin-foil. A "mask" is literally an ordinary mask of starched muslin, such as children call a "false face." When coated with tin-foil it becomes a part of certain X-ray technique. The word "tube" always means a Crookes tube and the source of X-radiation, unless otherwise stated in the text. The "focus" is the point on the anode from which the rays start. The Anode is the diagonal electrode within the tube, and is always to be connected with the positive pole of the electrical apparatus. The Anode is often called the anti-cathode. The Cathode is the round electrode in the tube, and is connected with the negative pole of the current. A "spreader" is a wooden or vulcanite rod on the tube-holder designed to keep the cords connecting the tube with the current widely apart. Many minor words define themselves by the context. As skiagraph and radiograph mean the same thing it is customary to use the one which fits best in a given sentence, and the reader need not infer that one is superior to the other.



## Studies in Photo-Therapy

*"To-day scarcely any one doubts the energetic therapeutic action of blue electric light."*—(MININ.)

## CHAPTER XLIV

### LOCAL PHOTO-THERAPY

A RUDIMENTARY EXPLANATION. FINSSEN'S WORK. PHOTO-CHEMICAL THERAPY. EXPERIMENTAL DATA. TECHNIC OF FINSSEN'S LUPUS METHOD. DETAILS OF TREATMENT IN FULL. NEW LUPUS LAMP. METHOD OF TREATMENT WITH THE LORTET-GENOUD LUPUS LAMP. THE FOVEAU-TROUVE LAMP. PROGRESS IN PHOTO-THERAPY LAMPS. SUN CASES.

THE scientific and advancing photo-therapy of the twentieth century has begun with two sharply distinctive lines of research and development, one seeking strictly local and photo-chemical actions and the other mixing the chemical with the luminous and red rays and dosing their proportions to meet local and general indications of an entirely different character. Three general terms have arisen to express the three branches of work now done with electric-light apparatus of different kinds; Finsen's therapy, Light treatment, and Radiant Heat Baths. The photo-therapy allied to Finsen's work deals mainly with very small local applications of *cold chemical rays* of light to lupus and similar small lesions which are adapted to its minute contact-device. "Light treatment" is the larger and more general application of the chemical or mixed rays, or even whole-light from certain lamps, for tonic and nutritional purposes as an intensified sun-bath, especially in the treatment of pulmonary tuberculosis, and general skin diseases amenable to "light" action. Radiant Heat employs whole light with special reference to the production of "warm sunshine," and occupies the therapeutic field of super-heated dry air with important advantages which will appear in our course of study.

Photo-therapy is dependent on mechanical variations in the construction of sources of light which will permit the selection of such rays out of the spectrum as will have the needed physiological actions, and as great advances are promising in this way we commend the study of this section with confidence that before this book is old